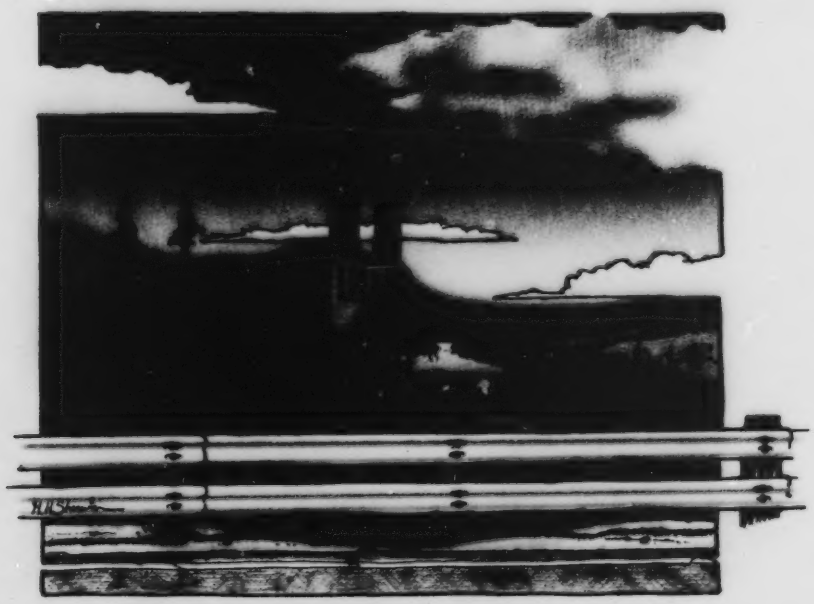
WETLAND MITIGATION IN CANADA

A FRAMEWORK FOR APPLICATION



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Edited by

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Allison Grose

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Issues Paper, No. 2000 - 1

North American Wetlands Conservation Council (Canada)

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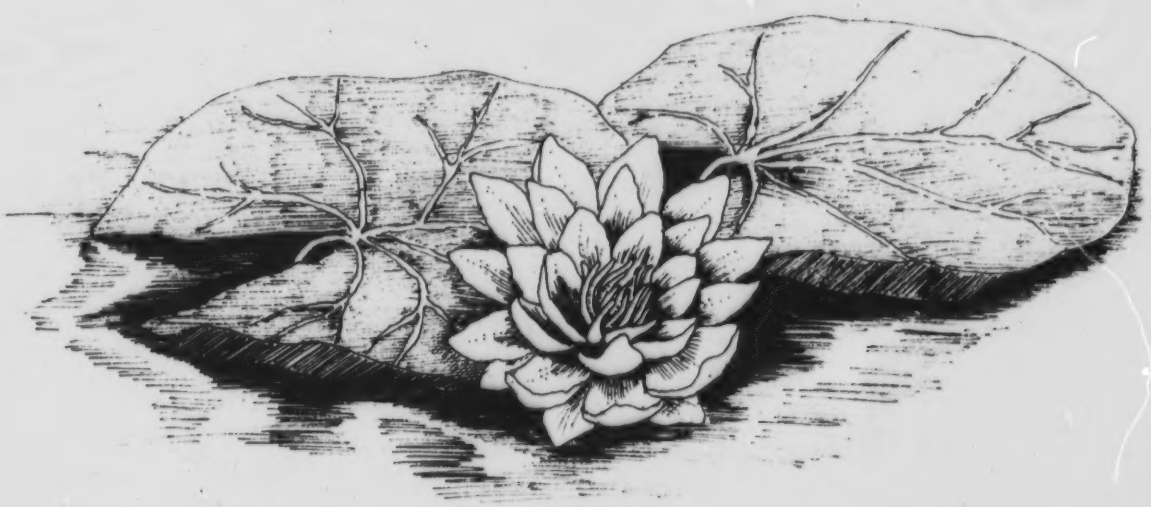

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Foreword

As the North American Wetlands Conservation Council (Canada) (NAWCC) enters its 10th year, we look back on past successes, and forward to continuing challenges in wetland conservation. In the past decade, there have been significant developments in the area of wetland conservation policy in Canada at all levels of government and within industry. Awareness and recognition of the importance of wetlands continues to grow. However, even with these positive developments, wetland losses mount as the result of pressures from agriculture, industrialization, urbanization and other land uses across Canada.

Nonetheless, governments, non-government organizations, industry and others have recognized the need for development that is sustainable. Although far from universal, there is a genuine and widespread interest in conserving wetlands, while allowing for necessary developments to proceed. Unfortunately, while there is a will to mitigate the effects of developments on wetlands, the capability is not always present. In Canada, there is no standardized, consistent approach to wetland mitigation. The NAWCC (Canada) recognized that there was a need for guidance, for a blueprint that those with the responsibility for developments and for land management could use to help them fulfill a commitment to wetland conservation.

This paper, developed through an extensive consultation process, is published to help fill that void. It is part of a multiphase initiative, the Wetland Mitigation Project, that is designed to advance the state of wetland mitigation in Canada. The document sets out a series of principles that should underlie the approach to mitigation, and a set of guidelines that give direction to the mitigation process. These principles and guidelines have been adopted by the NAWCC (Canada) for the mitigation process for North American Waterfowl Management Plan (NAWMP) projects in Canada, should there be a NAWMP project wetland threatened with disturbance and/or development.

The series of case studies, reflections and practical framework contained in the document offer additional guidance, through lessons that others have learned. Future activities envisioned under the Wetland Mitigation Project include wide distribution of this document across Canada, urging federal, provincial, territorial, aboriginal and municipal governments to recognize its strengths and adopt it for their region and mandate. It is hoped that industry, be it construction, transportation or other, will look positively on the document and adopt it for use in their development projects. The NAWCC (Canada) Secretariat looks forward to providing guidance and consultation on any of the concepts in the document, and welcomes discussions for improvement. The Secretariat will also be encouraging workshops to publicize and promote its use.

We urge you to consider adopting the wetland mitigation approach described in this document, and to establish your own guidelines applicable to your particular activities and endeavours. A more consistent application of this approach to wetland mitigation will add a powerful tool to help conserve Canada's wetlands.

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1.0 Wetland Mitigation in Canada

— Allison Grose, Robert O. Bailey and Kenneth W. Cox

This publication brings together the current thinking on wetland mitigation in Canada. It offers an approach to mitigation that, if followed, will help advance wetland conservation in Canada. The introductory chapter gives a brief history of the Wetland Mitigation Project, defines the audience for the document, and places wetland mitigation in a broader conservation context. It defines wetland mitigation, and outlines a series of principles and guidelines that underpin and give direction to the mitigation process.

A series of case studies detailed in the second chapter describe how wetland mitigation occurred in a variety of situations across Canada. The third chapter outlines a framework for implementing the mitigation process. Finally, the reflections in the fourth chapter relate in a broad sense to what has been learned since the beginning of the Wetland Mitigation Project, but also draws lessons more directly from the case studies in Chapter 2.

Literature cited in each case study immediately follows the text for easy referencing; all literature cited within the publication, including the case studies, is included in Chapter 6. A list of contributors is at the end of the publication.

1.1 Background

Wetlands and wetland-supported ecosystems are under continual pressure from agriculture, industrial development, urbanization and other land uses across Canada. In recent years there have been a number of high profile cases of developments that affected wetlands, and for which mitigation measures, including compensation packages, were negotiated. These include:

- the parallel runway at the Vancouver International Airport;
- the consolidated Canadian Museum of Nature facility at Aylmer, Quebec; and
- the Trans-Canada Highway realignment through Grand Lake Meadows, New Brunswick.

These are only the tip of the iceberg — smaller scale, lower profile examples also abound. As developments increase in number, more and more of these situations will arise.

To date, the application of the mitigation process has generally been on an ad hoc basis, primarily because no standardized, accepted procedure exists. A fundamental building block of developing a standard procedure is the determination and acceptance of key terms to be used in documentation, in addition to a standardized approach to mitigation based on consistent principles and guidelines. Such an approach should be useful for policy-makers, planners, practitioners and others, and should be transparent and predictable for proponents.

The Wetland Mitigation and Compensation Project

In late 1996, the North American Wetlands Conservation Council (Canada) (the Council) launched the Wetland Mitigation and Compensation Project. Although originally conceived as the Wetland Mitigation and Compensation Project, considerable discussion has led to a conscious decision to include "compensation" as part of the mitigation process: see discussion under "Defining Wetland Mitigation" herein. The project is now referred to as the Wetland Mitigation Project. The Project, as conceived by the Council Secretariat and its Partner agencies, had the objectives of: 1) examining both the Canadian and U.S. experiences and attitudes towards wetland mitigation, and 2) developing a comprehensive set of definitions, principles and guidelines, as well as procedures for applying the wetland mitigation process.

Several stages of the Project have been completed. Two background papers outlining the Canadian and U.S. experience were produced in the Spring of 1997. In April 1997, a National Workshop was held to discuss ethics, procedures and approaches to mitigation and compensation in Canada. A Proceedings of the Workshop (including the background papers) entitled *Wetland Mitigation and Compensation:*

Proceedings of a National Workshop, was published by the Council in June 1998.

Interviews were held with wetland practitioners across Canada to develop the background paper on Canadian experiences with wetland mitigation. Many practitioners deemed it important to develop consistent definitions. In addition, one of the recommendations of the workshop was to prepare standardized definitions for key terms such as "mitigation," "compensation," "minimization," "restoration" and "avoidance." A number of the attendees also thought that it was important to establish a series of principles and guidelines for applying the mitigation process in situations where wetlands are at risk.

Acting on the recommendations from the workshop, the Council Secretariat undertook an extensive consultation process after compiling a series of draft definitions, principles and guidelines. In addition to distributing over 150 of the draft documents for comment, the Secretariat held discussions with various groups and individuals during the development of the final versions, to develop a comprehensive vision of the needs and perspectives of potential audiences for this paper.

The Secretariat also felt that it would be useful to illustrate the definitions, principles and guidelines with a series of case studies focusing on actual situations where developments impinged on a wetland and a mitigation package was negotiated. The case studies involve a broad range of projects, both large and small, from across Canada.

Finally, the Secretariat commissioned a report from Dr. Robert O. Bailey (see page 57) that details a practical framework for utilizing the mitigation process, and in particular the latter two stages of mitigation, namely, minimization and compensation.

Audience

During the process of consultation for this document, numerous calls for a standardized approach to wetland conservation in general, and wetland mitigation in particular were heard. Representatives from the federal government stressed the need for an approach that could be used by all departments, and yet would also garner provincial support. Provincial representatives wanted an approach that was also consistent with their own policies. It was also important to find an approach that would resonate with land managers and practitioners, those most responsible for on-the-ground management.

The Council mandate includes serving as a national forum for facilitating and monitoring the development and implementation of wetland conservation policies and wetland awareness programs in Canada. Therefore, this paper was developed for the broadest possible audience. The Council has no legislative authority, but in its role as a cross-Canada watchdog for wetland issues, offers this paper as a guide for all involved in wetland conservation. The recommended definitions, principles and guidelines are consistent with existing policies, such as *The Federal Policy on Wetland Conservation* and various provincial and territorial wetland policies (see Lynch-Stewart *et al.* 1999), and also with broader policies related to sustainable development, biodiversity conservation and climate change.

This paper has particular relevance to federal departments. It is often not recognized that the Cabinet directed that *The Federal Policy on Wetland Conservation* be applied to all federal policies, programs and activities. Thus, all federal departments have a responsibility to implement it. Therefore, this document is aimed at helping responsible authorities implement the policy.

However, the paper is not specifically aimed at the federal government. Any government department or agency, any industry, community group or individual involved in land management and/or project development will find this document useful, not only to help conserve wetlands, but to balance development and conservation priorities so that we all win.

1.2 Introduction to Wetland Mitigation

This paper gives guidance in the application of the mitigation process. It must be noted, however, that mitigation cannot be viewed as the panacea for wetland conservation. Mitigation is one process, or one activity, in the much broader context of policy and planning that incorporates conservation activities at every stage and every level. Prevention is the ideal conservation approach, and it is embodied in policies and programs such as those that encourage stewardship activities, for example. If the policy and planning process worked successfully, it would be a rare occasion when a development would be considered on a wetland, and the mitigation process would rarely have to be used.

Context

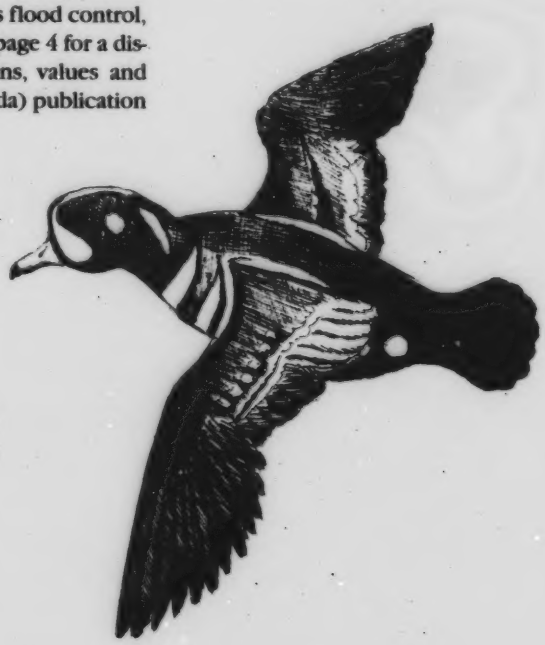
Wetland Conservation

Wetland conservation has been widely recognized as an important goal. Wetlands, once perceived as wastelands, have more recently been credited for providing a vast range of benefits to humans and other species. For example, wetland functions such as water storage and velocity reduction provide benefits such as flood control, saving lives and money. See page 4 for a discussion of wetland functions, values and benefits. The NAWCC (Canada) publication *Wetland Evaluation Guide: Final Report of the Wetlands are Not Wastelands Project* (Bond *et al.* 1992, p. 16) outlined an approach, illustrated with a Table, describing functions and values. Over time, comments on this Table, as well as more considered thought, has led to a modified, and hopefully, improved explanation of wetland functions, values and benefits.

Although some protection for wetlands exists in policies, legislation and agreements, innovative approaches are needed to conserve wetlands in developing landscapes. Mitigation has recently emerged as a potential option for maintaining wetland functions, values and benefits in the face of continuing development pressures.

Ecosystem Approach

Wetland benefits are not provided by wetlands in isolation from the surrounding landscape. Wetlands are part of larger ecosystems that function together, interdependently. Developments that are not directly on a wetland but that affect the local hydrologic regime, for example, may also affect the wetland. In addition, some wetland values, such as the production of waterfowl, are inseparable from associated



uplands. Conserving wetlands requires an understanding of how wetlands function within the larger ecosystem, and within watersheds. Wetland conservation refers to activities that maintain the functions, values and benefits of wetlands in a landscape context.

Wetland Mitigation and Sustainable Development

Advocating the use of the mitigation process to conserve wetlands fits squarely within the conservation paradigm of sustainable development, a paradigm generally accepted by government, industry and conservation groups both nationally and internationally. The use of the mitigation process as a conservation tool is based on the premise that the environment and the economy are inextricably linked, and that a healthy environment underpins a healthy economy in the long term. It recognizes that some development is inevitable, and that many developments have important benefits to society. However, it recognizes that wetland conservation also has important environmental, social, cultural and economic benefits. Pressures to follow sustainable development precepts, to maintain environmental, economic and social sustainability in land use decisions, will encourage compromises between individual and collective interests over the long term. Single purpose interests, whether wildlife, agriculture or development oriented, are facing increasing difficulties operating in isolation as social, economic and environmental awareness and pressures mount. Awareness among governments, industry and communities of the full array of ecosystem and resource values at stake in land use decision-making adds support for negotiating the compromises required to sustain wetlands.

The No Net Loss Principle

One of the main policy approaches to wetland mitigation, which has been adopted by the Canadian federal government and other governments and agencies across North America, and that also fits the sustainable development paradigm, is the "no net loss" principle. The no net loss principle acknowledges that wetland alterations will continue to occur, some naturally, and some through necessary and beneficial human activities. However, given the importance of wetlands, and the fact that wetland losses have been so significant in some parts of the country, their continued loss cannot be supported. Therefore, unavoidable wetland losses or impairments should be balanced with wetland restoration, creation and enhancement.

In addition to demonstrating a balance between economic and environmental interests, no net loss is a goal to reach for, one that is relatively simple to understand, theoretically tangible and measurable, and that also allows for flexibility. (For a more complete discussion of the no net loss principle see Lynch-Stewart 1992.)

The principles and guidelines in this paper were developed within the context of understanding and supporting sustainable development and the no net loss principle. However, it must be noted that the flexibility inherent in these approaches also allows for situations in which absolute protection, or a no loss principle, is appropriate, such as for unique wetlands. In landscapes where wetland loss has been extreme, a net gain principle may underpin wetland conservation activities.

Wetland Functions and Values

What are we conserving through wetland mitigation? What is it that we are preventing developments from affecting? What are we trying to replace when developments do have a negative effect on wetlands?

The main goal of wetland conservation is to preserve wetland functions and values, and the benefits that derive from them. Wetland functions are the natural properties and processes (physical, chemical and biological) of wetland ecosystems. Values are the human-centred capabilities that derive from wetlands, often divided into science/information, aesthetic/recreational, cultural/psychological, and production categories. Both functions and values provide human benefits in the form of

products, services or experiences. (See Table 1.1).

Therefore, what is critical to a successful mitigation process is:

- determining the functions and values associated with wetlands;
- determining the level at which the wetland is performing these functions; and
- determining the importance of these functions and values to people, as measured through benefits.

In other words, mitigation should consider what functions a wetland is performing, at what level, and when, where, and to what or to whom they are important. These become the objectives for mitigation measures, and performance measures for evaluating success (NAWCC (Canada) 1998).

Maintaining wetland functions is the key to maintaining values and benefits that flow from the functions. There are a number of accepted methodologies for assessing wetland functions. These include the *Ontario Wetland Evaluation System* (Ontario Ministry of Natural Resources 1993), the NAWCC (Canada)'s *Wetland Evaluation Guide* (Bond *et al.* 1992), the use of a

Table 1.1
EXAMPLES OF WETLAND FUNCTIONS, VALUES AND BENEFITS

Capabilities: Functions	**Benefits: Products, Services, Experiences**
Hydrological • Water storage • Velocity reduction • Groundwater recharge	• Flood control (lives saved, money saved) • Storm damage reduction • Erosion control
Water Quality • Nutrient removal • Toxicant removal • Sediment removal	• Contaminant reduction • Clean water • Health benefits
Habitat • Plants • Invertebrates • Fish, birds, mammals • Water supply, feeding, cover	• Hunting, fishing, bird watching
Capabilities: Values	
Science/Information • Specimens for research, zoos, botanic gardens	• Greater understanding of nature
Aesthetic/Recreational • Opportunities for photography, bird watching, hiking, swimming, hunting, fishing	• Personal enjoyment and relaxation • Direct economic benefits
Production • Birds, fish, plants, soil supplements	• Food • Fibre • Self-reliance for communities • Jobs/income

(Adapted from deGroot 1988, Filion 1988 and NAWCC (Canada) 1998)

hydrogeomorphic approach, as well as a number of other methodologies. In Canada, while we refer to and take guidance from these examples, we have no single accepted functional assessment and/or evaluation approach.

Business and industry, in particular, need to know how the functions and values are established. They need access to the procedures, technology and the decision-making framework and criteria. For example, if a developer knows how an assessment would be carried out and applied to a wetland environment in a river system, it would be easier to make decisions early about how to move forward. This could help avoid confrontations and costly problems. There should be an accepted system in place that takes the mystery out of the process and allows for advance planning.

Wetland values and benefits, that is, the importance of wetlands to people, are the currency that renders mitigation negotiations and processes understandable to all parties. Whether these values are presented in hard financial terms, or as the basis of benefits such as agricultural products, flood control, water quality or wildlife, it is critical to establish the nature of wetland functions and, where possible, use these values as the common ground for initiating the process. Proponents are more receptive to mitigation measures when they understand what they are trying to conserve. It is inevitable that situations will arise when there is a conflict between development and wetland conservation, and only if people recognize the benefits of wetlands will there be a real attempt to maintain environmental benefits in the face of development.

It is also important to make the point that wetland functions have significant economic benefits to people. Economic benefits derive directly from wetland products, tourism and recreation activities, flood control or water purification, for example. While the state of economic valuation of wetlands across Canada is not well researched, the following statistics, although not all attributable to wetlands, will demonstrate the magnitude of one value of wetlands and their adjacent habitat. In North America, more than 60 million people watch migratory birds and 3.2 million hunt waterfowl, generating over $20 billion annually in economic activity. In Canada, the 1991 *Survey on the Importance of Wildlife to Canadians* (Filion *et al.* 1991) estimated that $1.2 billion was spent on recreational waterfowl-related activities such as hunting and viewing migratory waterfowl. These expenditures contributed $1.6 billion to the Gross Domestic Product, generated $694 million in government revenue from taxes, and sustained 28,600 jobs. Canada's fisheries resources' value has been estimated at approximately $12 billion annually (Anderson 1998). Approximately three-quarters of this may depend on wetland environments.

However, there is a danger in using dollars as the only yardstick for negotiating and making decisions. This approach engenders competing economic value scenarios, disputes over figures and accusations of false economies on all sides. Experience shows that economic and environmental benefits and opportunities satisfy an array of social needs. A wetland assessment that determines both functions and values is key to the success of wetland mitigation negotiations because it creates a bridge between economic and ecosystem values.

Wetland functions are important to consider in another context. In a situation in which there is no alternative to a development going ahead and affecting a wetland, the functions and values particular to that wetland should be prioritized. If some loss of wetland function is inevitable, then decisions will have to be made as to what effects can and will be minimized, and what functions will be compensated. These decisions will determine the nature, extent and location of mitigation efforts. Determining priorities is an effort that will require the science involved in functional assessments, but also an understanding of local, regional, provincial, territorial and national priorities and objectives. It is therefore essential that stakeholders at all levels have the opportunity to participate in the mitigation process.

The purpose of establishing a mitigation process in the event of a potential disturbance to a wetland or wetland system is the retention and continuation of the functions of that system. The process is not intended to determine a dollar value for wetland functions in order to obtain a financial settlement for that disturbance. This is a very thin line to tread. It is a line that is easy to cross. Our intention must be and must remain the continuation of functions in wetland ecosystems.

Defining Wetland Mitigation

The term "mitigation" is used in different ways in different contexts and in different policy documents. Defining mitigation is more than a matter of semantics, or of using the most popular or common definition. Rather, the definition that is chosen reflects a philosophical position or approach to wetland mitigation. Because of this, a considerable amount of time and effort was spent examining the definitions in current use, and making a choice that best reflects a preventive or proactive approach to wetland conservation.

Current Canadian usage:
In Canada, there are a number of policy-related documents in which the terms "mitigation" and "compensation" are used. These include:

1. Fisheries and Oceans Canada *Policy for the Management of Fish Habitat/ Glossary* (1986):
   Mitigation: Actions taken during the planning, design, construction and operation of works and undertakings to alleviate potential adverse effects on the productive capacity of fish habitats.

2. Implementation Strategy No. 2: *The Federal Policy on Wetland Conservation* (Government of Canada 1991):
   [The federal government will] develop guidelines to ensure the mitigation of the impacts of federal government activities affecting wetland functions and, where appropriate, develop compensatory measures.

3. *Natural Heritage Reference Manual* (draft) (Ontario Ministry of Natural Resources in preparation):
   In the draft *Natural Heritage Reference Manual*, a technical support document being prepared to help interpret the 1996 *Provincial Policy Statement*, mitigation is defined as: "Includes the prevention, modification or alleviation of impacts on the natural environment. Also includes any action with the intent to enhance beneficial effects."

4. *A Guide to the Canadian Environmental Assessment Act* (Government of Canada 1993):
   Mitigation: means the elimination, reduction or control of the adverse effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

5. *Interim Alberta Wetland Policy/ Glossary* (Government of Alberta 1994):
   Mitigation: The process of rectifying an impact by repairing, rehabilitating or restoring the affected environment; or the process of compensating for the impact by replacing or providing substitute resources or environments. It can also be defined as the restoration, creation, or enhancement of wetlands to compensate for wetland losses associated with human activities.

6. *The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers* (Government of Canada: Lynch-Stewart *et al.* 1996): "Development of no net loss (NNL) directives should be guided by [the document entitled] *No Net Loss: Implementing No Net Loss Goals to Conserve Wetlands in Canada* and should contain the following elements:
   - A sequence of mitigation alternatives (e.g. "avoidance" of impacts, "minimization" of unavoidable impacts, and "compensation" for unavoidable impacts), with criteria associated with each option;
   - Compensation requirements (i.e.

related to function or area basis, type of wetland, geographic context, time frame), including definition of priorities and criteria;

- Compensation alternatives to restoration or creation of wetlands (direction on the acceptability of mitigation banking or non-wetland creation activities in working toward NNL goals); and
- Monitoring and maintenance requirements."

U.S. Terminology:

There are some differences between Canada and the U.S in the way these terms are used. Some terms, such as mitigation banking, have application in the U.S. but have no clear parallel in Canada. In much of the American literature, there is overlap between the definitions of mitigation and compensation. As with some Canadian usage, compensation is usually considered as a type of mitigation.

Mitigation: as defined by the U.S. Council of Environmental Quality in the *National Environmental Policy Act* regulations, includes: (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments (as cited in *U.S. Fish and Wildlife Service Mitigation Policy*, Government of the United States 1981).

The U.S. Fish and Wildlife Service (USFWS) *Mitigation Policy* "supports and adopts this definition of mitigation and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process."

Compensation: The term is not explicitly defined by the U.S. Council of Environmental Quality, except insofar as it is described as item (5) in the definition of mitigation, above. The USFWS *Mitigation Policy* defines "compensation" (in the context of the Service) as "full replacement of project-induced losses to fish and wildlife resources, provided such full replacement…[is] consistent with the appropriate mitigation planning goal."

Mitigation banking plays a key role in wetland conservation in the U.S., but thus far is not part of the Canadian conservation landscape. Mitigation banking is defined as the creation, restoration or enhancement of wetlands that will be sold or exchanged to compensate for future wetland losses incurred as the result of development. Typically, the created, restored or enhanced wetlands are designated as a bank. The value of the wetlands created, restored or enhanced are quantified and assigned credits, which can be sold or "withdrawn" to compensate for losses elsewhere (Marsh *et al.* 1996). The USFWS *Mitigation Policy* defines "mitigation banking" as "habitat protection or improvement actions taken expressly for the purpose of compensating for unavoidable losses from specific future development actions."

Recommended definition:

The key distinction between the mitigation definitions is that some refer to mitigation and compensation as two separate and distinct processes, and some include compensation as part of the mitigation process. The two cases in which the terms appear to be separated are the federal *Policy for the Management of Fish Habitat* and *The Manual of Implementation Guidelines for the Ontario Wetlands Policy Statement. The Federal Policy on Wetland Conservation* is somewhat ambiguous in this matter, but the *Implementation Guide* makes very clear the fact that compensation is part of the mitigation process. The *Guide to the Canadian Environmental Assessment Act*, the *Interim Alberta Wetland Policy*, and the U.S. Council of Environmental Quality also include compensation as part of the mitigation process.

The majority of these documents support the concept of a single process with several components, which is one reason to support this view. More importantly, it is the more recent documents, with the most clearly defined terminology, that support this view. A third point is, if we are going to develop broad-based definitions for wetland mitigation terminology, it makes sense that the definitions be consistent with the two key federal positions — environmental assessment and wetland policy.

There is another consideration. The two-process approach emphasizes mitigation, being the reduction of impacts, and compensation, being a variety of "replacement" options, but does not emphasize avoidance of impacts in the first place. If the key to wetland conservation is the prevention of impacts, then the first priority must be to prevent developments affecting wetland functions and values. Accordingly, a definition of mitigation should emphasize avoidance of impacts.

For all these reasons, "mitigation" is used in this paper as follows:

> **Mitigation** is a process for achieving wetland conservation through the application of a hierarchical progression of alternatives, which include:
>
> (a) **avoidance** of impacts;
> (b) **minimization** of unavoidable impacts; and
> (c) **compensation** for residual impacts that cannot be minimized.

The one drawback to this definition/approach is that even though many policies and other documents include elements of avoidance and/or compensation under the umbrella of mitigation, many people appear to instinctively think of "mitigation" and "minimization" as being the same. However, it is important to promote the message and encourage people to understand that mitigation contains a hierarchy of choices, the first always being avoidance. It is not easy to get people to change their way of thinking, to approach conservation as prevention, rather than fixing a problem. However, without guidance in this direction, the change in approach will not occur. Among the many uses of such a detailed discussion on this topic is its role in the education of all concerned.

The Mitigation Sequence

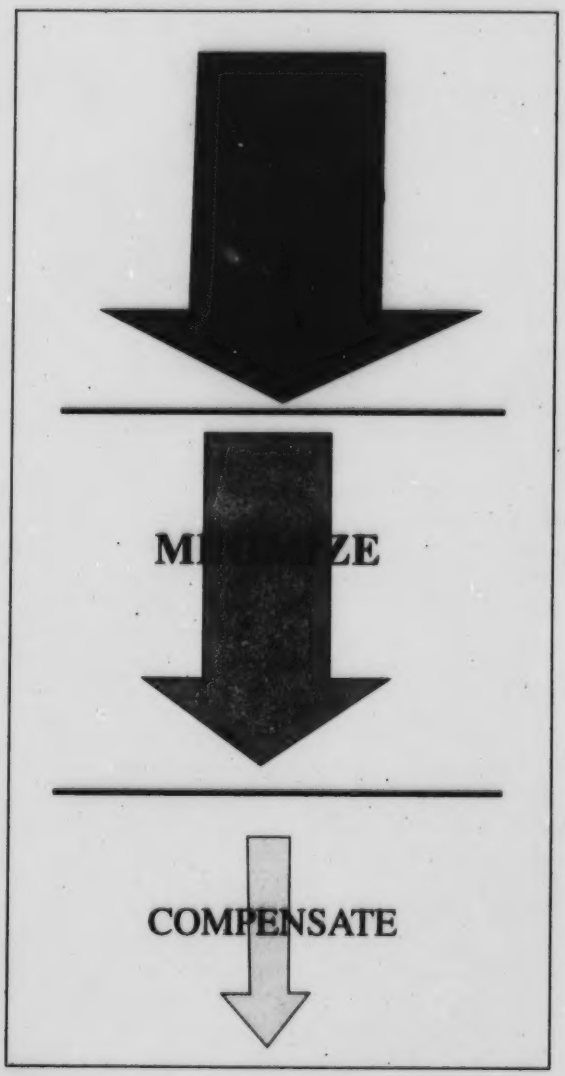
The sequence described below should be followed if the mitigation process is to be successful as a tool for wetland conservation (see Figure 1.1). In particular, the first two steps of the sequence should not be skipped for the sake of expediency. The steps between each stage should be perceived as huge barriers that are only to be breached in rare circumstances.

The first step, **avoidance,** involves the prevention of impacts, either by choosing an alternate project, alternate design or alternate site for development. It is the first, best choice of mitigation alternatives. Because it involves prevention, the decision to avoid a wetland or to redesign a project so that it does not affect a wetland must be taken very early in the planning process. It may be the most efficient, cost-effective way of conserving wetlands because it does not involve minimization, compensation or monitoring costs. It also avoids the uncertainty inherent in minimization or compensation activities that may not be successful because of the relatively undeveloped state of the science. Avoidance is therefore particularly crucial for high quality/unique wetlands, and wetlands of national or international importance. It should also be the choice in situations where cumulative impacts in a specific area exceed a certain threshold, and where impacts of even a small magnitude will result in significant negative effects.

The next step, **minimization**, should only be taken once the decision has been made that a project must proceed, that there are no reasonable alternatives to the project, and that there are no reasonable alternatives to locating the project on a wetland. Minimization involves the reduction of adverse effects of development on the functions and values of wetlands, at all project stages (including planning, design, implementation and monitoring), to the smallest practicable degree.

Compensation is the last resort in the mitigation process, an indication of failure in the two earlier steps. It should only be considered for residual effects that were impossible to minimize. Compensation refers to a variety of alternatives that attempt to "make up for" the unavoidable loss of or damage to wetland functions and values, usually by improving wetlands off-site from the development. Preferred methods include restoration and enhancement of wetlands, although the creation of a new wetland would also be a potential compensation method. Securement of a wetland alone would not normally be considered adequate compensation because it would not result in the replacement of lost or damaged wetland functions, but only in the protection of an existing wetland. However, there may be situations in which a combination of securement and other compensatory measures may be appropriate. Compensation may also include, but should not be limited to, the financing of

Figure 1.1
DIAGRAM OF THE MITIGATION SEQUENCE



wetland-related activities such as research and education.

In the past there has been a tendency on the part of both government and industry to take the expedient route and go straight to compensation rather than deal with potential impacts in the design stage or through avoidance. Large developers may prefer to pay for functional losses with a cash settlement or technological "quick fix." For example, it may be easier to pay for a fish hatchery rather than prevent or minimize damage to a spawning habitat. It is often in the company's best interest to find a quick solution, write off costs, and proceed with the project. However, environmental impacts are seldom resolved by this approach.

Mitigation banking is a compensation alternative in the U.S., although not, so far, in Canada. However, inevitably any discussion about mitigation raises the question of whether mitigation banking has a role to play. Historically, the U.S. experience has not been very positive, for a number of reasons (see discussion in Loftus and Mansell 1998). Mitigation banking does allow for some flexibility, and it also allows for compensation dollars to go to priority sites. However, it can also encourage a "commodity" approach to conservation wherein wetlands are traded for cash. Perhaps more importantly, it places emphasis on compensation rather than avoidance or minimization, and allows the mitigation process to be circumvented. For these reasons, it is recommended that mitigation banking as it is conventionally defined, does not become part of mitigation in Canada. As an alternative, advance planning that identifies priority wetland areas and directs compensatory funding to these areas, is recommended.

It should also be noted that the science supporting some aspects of wetland mitigation in Canada is not well developed, and contains a degree of uncertainty and inherent risk, particularly as it relates to wetland replacement and creation. Because of this, monitoring is an integral part of mitigation. While not strictly a stage of the mitigation process, monitoring must occur to determine success or failure of minimization and compensation efforts so we can learn from our mistakes. In any mitigation package that is negotiated, monitoring must be included within both minimization and compensation activities. Monitoring costs should also be factored in to project costs.

1.3 Mitigation Principles

A clear set of broadly applicable principles is required for wetland mitigation in Canada. Principles, which embody "fundamental truths," give an underpinning philosophy or perspective. They should be broadly applicable in all situations, and for the purposes of this paper, should be national in scope. Sixteen such principles are listed below.

1. Wetlands are one of the most productive ecosystems on earth, and are an integral component of Canada's landscapes, providing significant environmental, social, cultural and economic benefits. These benefits make wetlands a priority for conservation efforts.
2. Canada has a leadership role to play in the conservation of wetlands. The NAWCC (Canada) has a facilitation and coordination role in providing guidance to all levels of government and the private sector in delivering wetland conservation.
3. Mitigation is a component of a broader approach to wetland conservation that should include policy, advance planning, protection, environmental assessment, stewardship, wetland inventory and monitoring, and research.
4. Mitigation is a process, which should begin with avoidance, proceed through minimization only if avoidance is not possible, and consider compensation only as a last resort.
5. The mitigation process and appropriate mitigation measures should be applied to all stages of a project: from planning, siting, and designing, through implementation and monitoring.

6. Wetland mitigation policies and actions should be consistent with the goals of Canada's national and international conservation agreements including the World Conservation Strategy, the Convention on Biological Diversity, and the Convention on Wetlands of International Importance (Ramsar 1999).

7. Mitigation should be consistent with local policies, legislation and standards, and flexible enough to address social, economic and environmental variability across Canada. This is most likely to be achieved with the participation of all stakeholders.

8. Mitigation must be sustainable from an environmental, social and economic perspective.

9. Policies, guidelines and procedures should be applied in a consistent and equitable manner with respect to all sectors, levels of government and interests.

10. Wetland conservation through the mitigation process should be planned on an ecosystem basis and in a landscape context to minimize risks to the diversity and integrity of wetland-supported ecosystems, and to enable consideration of cumulative and downstream effects.

11. Sustaining the full range of wetland functions and values is the primary focus of mitigation processes.

12. Measures undertaken to restore or replace wetland functions and values should be ecologically sound and supported by the best available scientific information.

13. Monitoring should be considered an essential component of wetland mitigation efforts. It is required to ensure that:
    - mitigation measures are implemented in accordance with approved designs;
    - the effectiveness of the measures is assessed; and
    - contingency measures are in place, should the measures not achieve the design objective.

14. The mitigation process must be transparent, accessible, timely and efficient. Mitigation solutions should be reasonable — cost effectiveness should be a consideration in negotiating mitigation packages.

15. There is a need for change in Canadians' perception of wetlands. Public awareness of wetland functions and values and the benefits they provide to society will be key to encouraging community support for mitigation measures.

16. No one group should be expected to bear the entire burden of policy decisions regarding mitigation. There must be some consideration of what constitutes an equitable sharing of costs among, for example, proponents of the development, beneficiaries of the development, and the beneficiaries of wetland conservation in general, i.e. "society."

1.4 Mitigation Guidelines

A set of guidelines is the foundation of a conceptual model for wetland mitigation in Canada. Guidelines help by giving advice, directing the process, and providing a conceptual framework.

Avoidance Guidelines

Avoiding the impacts of developments on wetlands is the most efficient and effective mitigation strategy. It is also the simplest and most straightforward to understand. For this reason, even though avoidance is the most favoured choice among the alternatives, it has the least space in this document. Accordingly, four guidelines to direct when avoidance is the appropriate choice follow:

1. Avoidance should always be considered as the first alternative for any development that could potentially affect a wetland.

2. Avoidance should be the only choice where the wetland concerned is of regional, provincial, territorial, national or international significance.

3. Avoidance should be the choice in areas where wetland losses of a large magnitude have already occurred, or where cumulative losses have already reached the point where losses of a small magnitude will have a significant effect.

4. In cases where effects on a wetland are such that losses of values and benefits are significant, and where minimization cannot ameliorate these effects, development should be avoided.

Minimization Guidelines

There will be some cases in which developments on wetlands cannot be avoided entirely, and in such cases effects should be minimized to the greatest extent possible. The following 10 guidelines are proposed to determine minimization procedures and measures:

1. National mitigation guidelines should be adapted to suit specific requirements in different regions or sectors. Detailed mitigation standards and procedures for some activities have been developed by industry and government, and are being applied in progressive industries to guide operations. More work is needed to refine guidelines for sectoral activities and to develop innovative mitigation technology.

2. Procedures and techniques should be based on sound ecological principles and the best science available.

3. Proven measures are preferred over new or experimental techniques. New and experimental approaches should only be considered where proven techniques cannot be applied satisfactorily. They should, however, be carried out on a pilot basis and monitored to assess effectiveness.

4. Monitoring is required to evaluate the outcome of mitigation applications. The cost of monitoring should be factored in to any mitigation process.

5. An iterative or adaptive approach should be taken to improve knowledge and effectiveness of mitigation measures over time.

6. Procedures, technologies and applications should have some flexibility to address local concerns and conditions.

7. Minimization techniques should take natural succession into account, and should provide for environmental variability over time.

8. Minimization measures should remain functional as long as the project has reasonable potential to impact the environment.

9. Small-scale measures that can help control cumulative wetland losses should be implemented.

10. Incentives should be used to encourage the adoption and use of mitigation technologies in industry, governments and among private landowners.

Compensation Guidelines

Although compensation is the last resort in the mitigation process, inevitably there will be cases in which developments will go ahead on wetlands, and minimization efforts will be insufficient. In these cases, the following 12 guidelines are proposed to determine appropriate compensation:

1. Compensation requirements should be determined on a case-by-case basis, and should be prioritized, based on function/functional area, type of wetland, geographic context and time frame, etc.

2. The preferred method of compensation for wetland functions is restoration or enhancement of other degraded wetland habitats, and then creation of replacement wetlands.

3. Functional losses should be restored in the following order of priority:
   - on-site,
   - as close to the site as possible,
   - in the same ecosystem.

4. Functional losses should be restored first in the same wetland type, or second, with another wetland type.

5. Compensation ratios are justified based on the inherent uncertainty of replacing the loss of wetland functions. Ratios may be greater than 1:1 (wetland restored/recreated to wetland lost), depending on the degree of uncertainty with respect to replacement of the lost functions. Compensation ratios should be negotiated both for wetlands directly impacted by the development, i.e. within the development "footprint," and for those areas indirectly affected.

6. Compensation for impacts on the social and cultural values of wetlands may include, but should not be restricted to, financial compensation to be used for activities appropriate to the site. These may include building public access facilities and interpretive centres, developing public education materials, or conducting research. Financial compensation should only be considered as an option if the restoration/enhancement/creation of a wetland will not replace the lost social and cultural values. Financial compensation should be established on a project-by-project basis. In fact, compensation does not have to involve an exchange of dollars.

7. The cost of physical replacement and societal value can provide a basis for estimating financial compensation where such compensation is appropriate.

8. Compensation measures should have at least as much resilience to environmental change as the habitat they replace. They should remain effective throughout the lifetime of the project and beyond.

9. Compensation requires monitoring the outcome of measures undertaken to replace or restore wetland functions. The monitoring process should be transparent and accessible to the public.

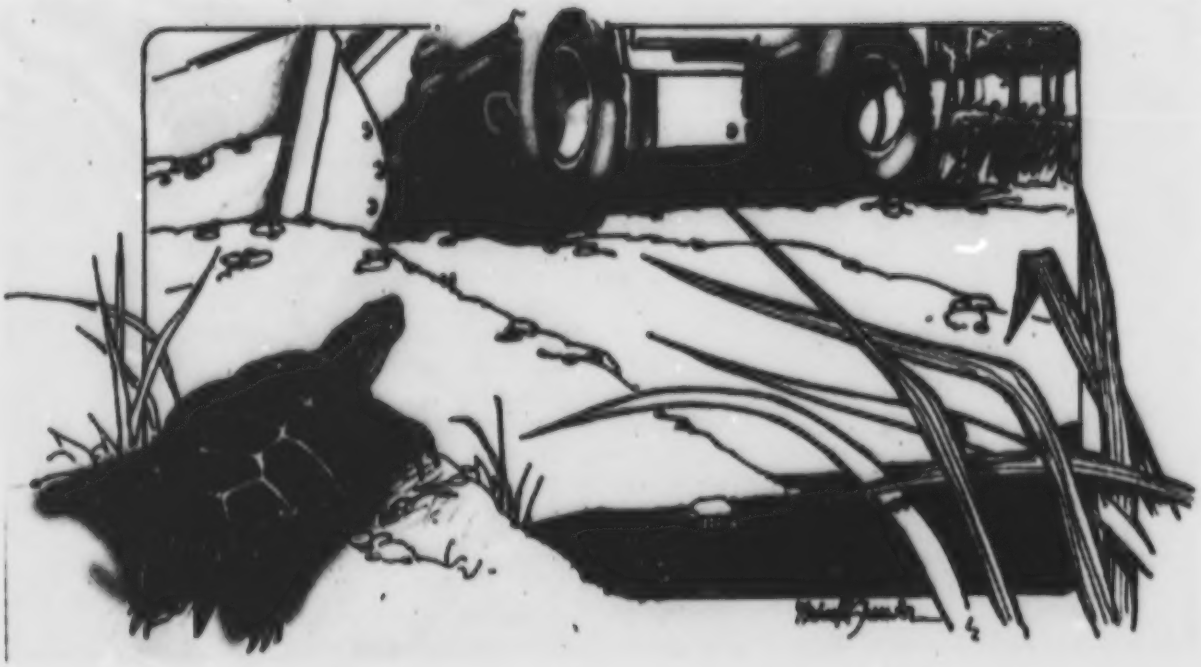
10. Proponents should demonstrate the efficiency and effectiveness of compensation measures in terms of replacing wetland functions.

11. An iterative approach, based on scientific evaluation, is needed to improve the reliability and performance of compensation measures. Adaptive approaches should be designed to reduce uncertainty with respect to mitigation options.

12. The science supporting wetland compensation in Canada is not well developed and contains a degree of uncertainty and inherent risk. However, the fact that this science is still developing should not prevent decisions being made, based on the best science available.

2.0 Case Studies

The following case studies illustrate a range of projects, from small to large and from coast to coast, all of which affected wetlands to a greater or lesser degree. In each case, a different process was used to determine what mitigation measures would be taken. There are lessons to be learned from the positive results that were achieved in these cases, but there is also much to be learned from our mistakes — from processes that were not effective, and from results that were less than successful.



2.1 Canadian Museum of Nature Aylmer Consolidation Facility: Important Lessons About Applying the *Federal Policy on Wetland Conservation*

— Pauline Lynch-Stewart

The Canadian Museum of Nature Consolidation Facility at Aylmer, Quebec was one of the first major federal projects to apply the *Federal Policy on Wetland Conservation* (Government of Canada 1991). As such, the experience offers a number of lessons about the importance of early identification of wetlands on potential project sites, about the value of understanding the requirements of the *Policy*, and about practical implementation of *Policy* objectives and guidelines. This case study tells a story about how project proponents — who thought they were "proceeding by the book" — were plunged into a heated, year-long public controversy that threatened to halt the project after construction had started. Museum executives, currently pursuing a long-term stewardship plan for the site and adjacent wetland area, are determined to turn the one-time crisis into a model for managing a large wetland property.

Major Parties

- Public Works and Government Services Canada — Purchased, in consultation with the National Capital Commission, the property in Aylmer, Quebec, which would be later proposed as the site for the Canadian Museum of Nature Consolidation Facility; acted as project proponent or "responsible authority" for the environmental assessments.
- National Capital Commission — Conducted initial assessments for the purchase and planning of the property.
- Canadian Museum of Nature — Initiated the project, although Public Works and Government Services Canada acted primarily as project proponent or "responsible authority" for the environmental assessments.
- Environment Canada — Quebec Region — Provided expert advice on the environmental assessment of the project, and on the interpretation and application of the *Federal Policy on Wetland Conservation*.
- Environment Canada — Headquarters — Provided expert advice on the environmental assessment of the project, and on the interpretation and application of the *Federal Policy on Wetland Conservation*.

Background/Issue

In the 1980s, the Canadian Museum of Nature initiated a strategy to consolidate their administrative functions and specimen collections — located in 11 buildings scattered throughout the National Capital Region — in one state-of-the-art facility. Public viewing of the collection would remain in the Victoria Memorial Museum Building, located in central Ottawa, Ontario.

In consultation with the National Capital Commission ("the Commission"), Public Works and Government Services Canada ("Public Works") acquired in 1990 a 73-ha property at 1740 - 1770 Pink Road in the City of Aylmer, Quebec. That property would constitute the federal government's main site for future development in the municipality, accommodating facilities for scientific research. The acquisition was made on the basis of a "purchase property assessment."

Museum administrators evaluated a number of options for consolidating their operations. They considered converting an existing building at 1770 Pink Road, and concluded that a new facility was needed to meet the high standards required for security and scientific reasons. The Museum considered constructing a new facility on the site of the Victoria Memorial Museum Building, or on a vacant lot near to the Victoria Building, or on-site on the Pink Road property. The latter proved to have the most favourable advantage-cost ratio.

In 1993, the Commission reported its *Assessment of Development Potential* on the 73-ha Pink Road property, concluding that the area "includes no geological, plant, animal or heritage resources enjoying special protected status under any federal, provincial, regional or municipal jurisdic-

tion." It also indicated that "The property...is differentiated from its surroundings by the extent of its forest cover, which is highly advantageous for development purposes, in terms of the establishment of buffer zones and screens of vegetation. Further, it noted that development was prohibited along the creek as the land was subject to flooding, and that "the poor drainage conditions characterizing much of the site will give rise to additional building costs." The report identified two environmental constraints on the site: soil contaminated by chlorinated hydrocarbon compounds; and municipal restrictions prohibiting development in the area bordering the creek in the northeastern part of the site.

The *Assessment* recommended that the 73-ha property be subdivided into 43 parcels of land, six of which would be used for the Museum's Consolidation Facility. It directed Public Works to prepare a master plan for the site and to subsequently develop the Museum lots, followed by disposal of the peripheral lots. The *Assessment* noted that Public Works would then "be able to take advantage of the momentum thereby generated (with the development of a prestigious facility) — and the resulting rise in property values."

In 1993, on the basis of supplementary geotechnical studies, the Museum and Public Works agreed that a 17-ha site on the western side of the Pink Road property would be appropriate for the project and that the Consolidation Facility would be located on the southernmost part. In October 1994, Public Works informed the Museum of its intention to transfer custody of the 17-ha site to them. As one of the conditions of land-use approval, the Commission required that project proposals for the Pink Road property be accompanied by an environmental assessment.

Approach to Mitigation

Environmental Screening under the *Environmental Assessment and Review Process Guidelines Order*

In 1994, the Museum proceeded to determine the environmental factors that should be considered in the project's future phases. The Museum hired consultants to prepare an environmental screening report under the *Environmental Assessment and Review Process Guidelines Order*.

The environmental screening report (Jacques Whitford Environment Limited 1995) was submitted to the Museum's managers in February 1995. The report did not indicate that the site was primarily wetland. It identified two environmental features of most concern: potential contamination of soils and groundwater; and the presence of the Midland Chorus Frog and Clinton's Fern, both species considered rare in the Province of Quebec. The report concluded that, with implementation of the recommended mitigation measures, all of the potentially adverse impacts could be mitigated. The report also recommended a more detailed environmental screening of the project at the final design stage.

The *Canadian Environmental Assessment Act* was proclaimed in January 1995. The Museum decided that it would comply with the spirit of the *Act* for subsequent assessments of the proposed Consolidation Facility, although the Museum is an independent Crown Corporation and not bound to comply with the *Act*. Later, federal legal advisors concluded that Public Works, as the property owner, should be considered the responsible authority for the environmental screening, and that the transfer of the property from Public Works to the Canadian Museum of Nature "triggered" the *Canadian Environmental Assessment Act*.

Environmental Screening under the *Canadian Environmental Assessment Act*

In Spring 1995, the Museum awarded a contract for construction of the building. The contractor would rent the building to the Museum on a long-term basis. The contractor made changes to the initial plans for the Consolidation Facility, based on the environmental screening report completed under the *Guidelines Order*. These changes included: moving the building 45

metres toward the north of the site, redesigning the fire route and parking lots to respect a sensitive zone, and modifying the landscape design to keep more natural vegetation. The contractor planned to initiate an environmental assessment of the project under the *Canadian Environmental Assessment Act* in July 1995.

Public Concerns

In April 1995, controversy over the use of the Aylmer site heated up and continued for almost a year. During this period the Museum took 113 media hits — 110 negative and only three positive — mostly regional coverage, some national and one international. A local wetland expert identified the site as at least 80% wetland as indicated by vegetation and the presence of peat, and referred to surficial geology maps that confirmed that organic deposits covered most of the property. (Dugal 1995). Other citizens and organizations expressed their concerns about the project at a meeting in July 1995, including the Sierra Defence Fund, the Canadian Coalition for Biodiversity and the Ottawa Field Naturalists. They raised concerns about the considerable biodiversity of the site, the presence of species-at-risk, the potential loss of wetlands and the perceived contravention of the *Federal Policy on Wetland Conservation*. They pointed out the conflict between the Museum's mission as "champion of nature" and its decisions on the project. Participants wanted to know why the Museum apparently had not known from the outset that there were wetlands on the property, and urged them to find an alternative site for the Consolidation Facility. Newspapers ran headlines: "Canadian Museum of Nature plans to clear Crown forest to build a new place to study nature and wildlife" and "Comedy of errors." The project — which Museum personnel believed to be well underway and well-planned — became a major controversy in the Ottawa area and the topic of discussion among the highest placed individuals in the federal government.

In November 1995, the construction firm completed its *Environmental Screening Report* (Pigamon Inc. 1995) under the *Canadian Environmental Assessment Act*. That report benefited from consultations in late July 1995, with Environment Canada — Quebec Region, concerning the identification of wetlands on the property, and the interpretation and implementation of the *Federal Policy on Wetland Conservation*. It also drew on a comprehensive biological inventory conducted by the Museum in the summer of 1995, which confirmed a high diversity of about 340 vascular plants on site, and noted the presence of the regionally significant Slashed Avens.

The *Screening Report* stated that "a central aspect of the planning of this project concerns the application of the *Federal Policy on Wetland Conservation*," noting that approximately 15 ha of the 17-ha site were occupied by wetlands. It concluded that the project should proceed with mitigation measures, noting:

- "The construction of the building will probably stimulate the local and regional economy and its presence on the territory of the City of Aylmer will improve its tax base.
- "The functions of this wetland do not have a significant role in the ecosystem nor in the economy. On the other hand, we estimate that some of the wetland's functions will be impacted by the realization of this project. The perched groundwater table will be lowered down and some threatened species may support an increased stress. Consequently targeted mitigation measures are required."

The *Screening Report* recommended mitigation and monitoring measures to protect wetland functions during project construction and operation phases, including:

- Construction of a watertight service pit for refueling
- Use of piezometers placed at vulnerable locations to measure changes in water level
- Vegetation monitoring
- Protection and regular verification of the habitat of the Midland Chorus Frog
- Prohibiting use of pesticides and de-icing salt
- Creation, maintenance and monitoring of a retention swale

Further, to compensate for the loss of 4 ha of wetland caused by the construction of the building, the *Screening Report* recommended:

- Stewardship conservation of the residual wetland in the northern part of the 17-ha property; and
- That the museum solicit from Public Works a transfer of the balance of the 73.3-ha federal property at 1770 Pink Road, to integrate it with the wetland to the north (of the building) in one managed holding, and to develop a conservation program to include scientific and public awareness activities, including research on wetland ecosystems.

Public Works, as the responsible authority for the assessment, accepted the *Screening Report*. Clearing and construction of the Consolidation Facility commenced on the Pink Road site in mid-December 1995.

Independent Panel Review of the Environmental Screening

In February 1996, the new Minister of Canadian Heritage threatened to halt the project and called for an independent panel of Dr. Husain Sadar and David Cressman to review environmental screening documents pertaining to the Consolidation Facility.

A few days later, Sadar and Cressman (1996) reported:

> "Basically at issue is whether the (environmental screening) report's conclusion that residual impacts can defensibly be rated as 'not-significant' (after mitigation/compensation have been implemented) can be justified. If this is the case, then the project can proceed without having to move to the next stage of environmental assessment, i.e. a comprehensive study.
>
> "We have determined that this conclusion is reasonably sound but have identified several issues on the impact analysis which can and should be addressed in order to minimize environmental impacts and further respond to the expressed concerns of environmental interest groups."

In their assessment of strengths and weaknesses of the screening document, Sadar and Cressman looked at the "Adequacy, relevance and effectiveness of mitigation measures." They wrote:

> "It is perfectly clear that the (proposed project) impacts on the *Federal Policy on Wetland Conservation*. At least 4 ha of wetland will be displaced and more may suffer adverse impact over time. From a policy perspective this is not problematic. The policy clearly allows for:
>
> - No net loss of wetland functions
> - Mitigation of the impacts
> - Where appropriate, compensatory measures.
>
> "The key question is whether or not the (suggested compensation) constitutes a valid compensation for the loss of at least 4 ha of wetland. The lands in question are already wetlands. Since they are owned by the government they are also subject to the federal wetland policy and thus 'protected' for the long term. Handing long term control over to the CMN does not effectively replace the lost wetlands. It merely changes managers..."

Sadar and Cressman concluded that:

> "It was a principal finding of the review that the loss of at least 4 ha of wetland on land owned by the federal government (which invokes provisions of the *Federal Policy on Wetland Conservation*) should require a higher degree of compensation than allowed for in the Screening Report. Whatever the degree of compensation there needs to be a public commitment on the part of the federal government to undertake the necessary compensation."

Sadar and Cressman recommended that the project be completed as planned, and that additional steps be taken to strengthen the mitigation measures. To fully comply with the "no net loss" provision of the federal wetland policy and to accommodate the uncertainties in the predictions of impact on groundwater systems in the wetland around the margins of the building

site, Sadar and Cressman recommended that:

- The government consider restoring former wetlands or construct new wetlands on federal lands as near the site as possible on a replacement ratio of at least 2:1.

Further, they recommended that the Museum:

- "Should move quickly to have the residential segments of the 1770 Pink Road federal property transferred to its control and initiate preparation of the stewardship program on both properties;
- "Should consider developing cooperative programs with the National Capital Commission, regional and municipal governments, area schools and public interest groups for promoting scientific research and educational activities to make good use of the natural heritage of the wetlands in the stewardship program; and
- "To strengthen the effectiveness of the environmental inspection role and to offer a credible third party overview of impact monitoring, we also recommend specific ways of clarifying the inspector's authority. In addition we recommend the establishment of an independent panel of experts to oversee effective execution of the monitoring program and to assist in the development of the wetland stewardship program."

Process for Implementing Mitigation and Results

Minimization of On-Site Impacts

20 The Minister of Canadian Heritage accepted the recommendations of the Sadar-Cressman Report in February 1996. Construction of the Consolidation Facility continued through 1996 and was completed by the Spring of 1997.

- As recommended by the Sadar-Cressman Report, the Museum retained an environmental auditor to ensure compliance with the environmental aims of the Museum and the builder. The environmental auditor provided advice on site management, made recommendations on additional actions and monitoring activities to Museum management, and had the authority to issue work stoppages if serious contraventions were observed.

Also consistent with the Sadar-Cressman Report recommendations, the Canadian Heritage Advisory Panel was established in 1996 to monitor the work of the building contractor, the environmental auditor and progress on the stewardship program and the wetland compensation program. The Panel submitted its final report in March 1997 to the Minister of Canadian Heritage, concluding that the mitigation measures applied during building construction were generally in line with those recommended, and that they produced good results (Sadar and Senecal 1997). The Panel encouraged the Museum's efforts to prepare a stewardship plan for the Pink Road site, and to prepare criteria for selecting a wetland compensation site.

Museum staff initiated a monitoring program in 1998, to continue monitoring the impact of the building on the local hydrology, water quality, and to expand coverage of biological and hydrogeological data to the entire 73-ha Pink Road property. Preliminary results of the hydrological monitoring show that high volumes of water continue to drain from the water table in the immediate area of the building into the ditch along Pink Road. The Museum is applying supplementary mitigation measures to stem the flow, and continues hydrogeological assessments to better understand the ecology of the site. Thus far, the wetland occupying the northern half of the property seems unaffected by the construction of the facility.

Looking back on the project in 1999, the auditor made the following comments about what did and did not work with respect to specific mitigation measures (Haber pers. comm.):

- Clinton's Fern plants were not transplanted because construction began late in the year. A remnant woodlot was preserved on-site to preserve a few of the ferns. Loss of Clinton's Fern on the

construction site was balanced by the abundance of the rare fern in the northern woodlands that were not directly impacted by the construction.

- Natural areas adjacent to the construction site were protected by fences, but still suffered damage due to wind throw and exposure. These factors have drastically altered the remnant woodlot as a suitable habitat for the Clinton's Fern. The site lost most of its trees, and was replanted with young cedars to provide shade for the ferns. However, wind throw and exposure to sunlight resulted in the degradation of the site, including a tremendous influx of weeds that are outcompeting the natural vegetation and crowding the ferns.
- Early during construction, a raised berm of heavy clay was constructed on the northern perimeter of the preserved habitat. This worked very well in preventing runoff from the construction site from silting up the swamp habitat. It also created a dam that helped maintain water in the swamp.
- The Midland Chorus Frog did not use the habitat set-aside in the southwest corner of the site during the construction, but were heard in that habitat the spring after completion of the building. The Midland Chorus Frogs inhabiting the pond in the northern woodland sector of the property were not disturbed by the noise of construction.
- The presence of the environmental auditor on-site several times a week clearly had an impact on the construction process. For example, when a small spill of diesel fuel occurred, contaminated material was excavated within several hours of occurrence and placed in a toxic waste dumpster.

Stewardship of the 73-ha Pink Road Property

Public Works agreed in 1998 to transfer the remaining 56 ha of the 73-ha Pink Road property to the Museum. At the time of writing, the Museum anticipated imminent completion of this transaction.

As advised by the Sadar-Cressman panel, the Museum established a Round Table of experts to advise on stewardship of the 73-ha Pink Road property. Comprised of nine participants representing a range of interests in use and conservation, the Round Table submitted their *Environmental Stewardship Plan* (Canadian Museum of Nature Stewardship Plan Round Table 1997) to the Museum in November 1998. The *Plan* recommended the following to the Museum's Board of Directors: a definition of environmental stewardship, a vision statement for the site, guiding principles for planning and management, use of site zones, an ecological inventory, interpretation, education and communications programs, partnerships for stewardship activities, and a process to oversee plan implementation. The Museum reports that the majority of the recommendations are currently being acted on.

Off-Site Compensation for Wetland Function Losses

Early in 1998, the Museum established a Wetland Compensation Site Selection Committee to develop criteria for assessing and selecting an appropriate property for off-site compensation, the aim of which was "to be objective, to have scientific integrity and to be practical and fiscally responsible."

The Committee prepared the *Criteria for Selection of Wetland Compensation Site*. The document contains guidelines for candidate sites, such as selection of areas with federal or other land use control of adjacent wetland areas; and wetlands disturbed by land-use practices but "essentially vacant at present." The guidelines directed the Museum to avoid wetlands "lying directly within the path of urban development or other uses...because of the potential for substantial changes in hydrologic conditions in the upstream drainage basin." The Committee applied "site comparison criteria" to candidate sites identified by federal departments, to select the preferred site. Six site comparison criteria, presented below, are associated with values that would result in a high, medium or low rating for that attribute on the site:

- Similarity of abiotic functions
- Similarity of biotic functions

- Landscape position
- Sustainability of site conditions
- Interpretative value
- Cost of acquisition/restoration

Environment Canada — Quebec Region (the Region) advised that compensation should focus, when feasible, on replacing specific wetland functions that have been lost as a result of the original development, through the enhancement or restoration of a wetland that is a similar wetland type, in a comparable position in the landscape. The Region emphasized that it is the wetland functions that are important — not the wetland area, and that each wetland type is associated with specific functions, some of which cannot be replicated in a wetland of another type. However, the Region recognizes the current difficulty of pursuing this principle in the absence of more detailed, practical guidelines on compensation under the *Federal Policy on Wetland Conservation*, and stresses the need for flexibility in implementing compensation measures.

At the time of writing, the Committee continues to consider candidate sites for compensation.

Reflections

The controversy surrounding the Museum's development of the Consolidation Facility on Pink Road can be traced to two factors:

1) Failure to recognize, early in the project planning process, that the Pink Road property was dominated by wetlands.

   The purchase property assessment, the assessment of development potential, and the initial environmental screening report under the *Guidelines Order* did not identify wetlands on-site, although reference was made to poor drainage conditions characterizing much of the property. (It must be noted that the purchase property assessment was completed and the property acquired in 1990 *prior to* Cabinet approval in December 1991 of the *Federal Policy on Wetland Conservation*.)

Implementation of the *Federal Policy on Wetland Conservation* is the responsibility of all federal departments and agencies. Federal property managers and environmental assessment practitioners should have a basic knowledge of wetland ecosystems and the requirements of the *Policy*. The Canadian Wildlife Service of Environment Canada and the North American Wetlands Conservation Council (Canada) can provide assistance in this area.

What if wetlands had been identified on the site, and the ecological importance of this property recognized? What if federal officials had followed current guidelines regarding wetland policy and avoided purchase of the Pink Road site as a federal development node? Clearly, wetlands at this location will fare relatively well in federal ownership, considering the site was zoned for industrial development. Would a private landowner have invested in wetland conservation — recognized as a "common good" and the business of governments — as the federal agencies have committed to doing? If the site was worthy of protection for the ecological services that it provides, perhaps the real issue here relates to the original designation of the site for "industrial use" on regional land-use plans?

2) Failure to provide, at an early state of project planning, an opportunity for public involvement in decisions concerning the location of the Consolidation Facility.

   A proactive approach to public participation in these decisions may have changed the course of events surrounding development of the Facility. The federal government is now committed to conserving the remaining portion of the 73-ha Pink Road property, and Museum executives are determined to make the site a model of wetland management. Communicating this vision for the property to the public at the outset of the project would

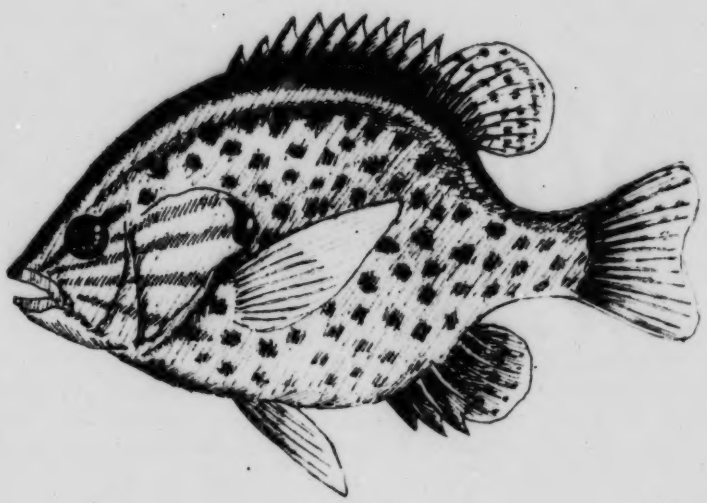
likely have resulted in a much more positive, publicly supported process.

The *Federal Policy on Wetland Conservation* commits federal departments to no net loss of wetland functions as a result of land management decisions. The *Implementation Guide* points out that this can be achieved by applying a sequence of actions including avoidance, minimization and compensation. Avoidance is the priority, and implies the search for an alternative site or project design to prevent the loss of wetland functions. It is not clear whether "avoidance" — as recommended by the public in the July 1995 meeting — was actively considered after the project proponents were aware of the presence of wetlands on the site. Perhaps in this case avoidance was not an option because the property had been purchased prior to the Cabinet approval of the *Federal Policy on Wetland Conservation*. Was the Museum committed to the site before it was recognized as a wetland?

Once the decision was taken to move ahead with the project on the Pink Road site, a mitigation strategy was designed to minimize the impact of the project on wetland functions on the property. Some of the mitigation measures worked well, as detailed in the Results section of this case study, such as the environmental auditor and the construction of a clay berm between the construction site and the natural area. However, mitigation measures do not always work as planned, as also noted in the Results section, stressing the importance of the first step of the mitigation sequence. All efforts should be made to avoid — through project siting or design — the loss of wetland functions.

The final mitigation option in the three-phase sequence is compensation. The *Implementation Guide* notes that compensation should be practised only as a last resort and only under certain conditions. The Consolidation Facility project raised two important points about compensation: that protection of another wetland does not constitute compensation because it does not replace the lost wetland functions. As the Sadar-Cressman Panel pointed out, "Handing long term control over to CMN does not effectively replace the lost wetlands. It merely changes managers..." Also, the project serves as a reminder that compensation efforts should focus, where feasible, on replacing the specific functions that have been lost on the development site, by restoring a wetland of a similar type, in a similar position in the landscape.

However, Environment Canada — Quebec Region cautions that, for the time being, environment agencies need to exercise some flexibility in advising on compensation for lost wetland functions. To enable progress towards wetland policy objectives, the federal government needs to develop better, practical, "made in Canada" guidelines that detail scientifically defensible and reasonable means of assessing wetland functions and mitigating impacts on these functions. To date, Environment Canada — Ontario Region has made an excellent start at the necessary guidance with their participation in the development of *Temperate Wetlands Restoration Guidelines* (Mansell *et al.* 1998) and the related training program. The *Restoration Guidelines* document sets the standard for the level of detail required in guidelines for



functional assessment and the application of mitigation to wetland projects.

The Sadar-Cressman Panel decision articulated some other important points about application of the *Federal Policy on Wetland Conservation*: regarding the flexibility inherent in the no net loss policy, and the need for public commitment on the part of the federal government to undertake the necessary compensation. The Panel misled its audience, though, in stating that "Basically at issue is whether the report's conclusion that residual impacts can defensibly be rated as 'not-significant' (after mitigation/compensation have been implemented) can be justified." The *Implementation Guide* clearly states that "Compensation cannot be used to reduce the assessment of 'significance' of adverse effects, and therefore only avoidance and minimization of environmental effects is considered" prior to the decision to proceed or not proceed on the project. However, having indicated that significance of residual impacts should consider "mitigation/compensation" measures, the Panel seems to base its agreement with the *Screening Report* conclusions on the "non-significance of residual impacts" on the importance of the ecosystem within the landscape.

Implementation of the mitigation recommendations related to the transfer and stewardship of the remainder of the 56 ha of the Pink Road property have been slow in coming. This delay points to the economic challenge of implementing wetland conservation objectives. At one point, transfer of the remaining 56 ha was delayed because Public Works felt that the action conflicted with their commitment to the federal Treasury Board to get fair market value for the sale of the land. No doubt that the City of Aylmer is disappointed in the loss of future economic gains associated with industrial development of the land. However, research on the economic evaluation of wetlands suggests that these gains may be dwarfed by the value of the ecological services of the site, related to hydrology, water quality and habitat (Costanza *et al.* 1997).

Despite these challenges, the no net loss objective in the *Federal Policy on Wetland Conservation* provides "a beacon" towards which we strive. Although we currently may not have the scientific and technical capacity to "make up" for losses or, indeed, predict what those losses may be, our inability to immediately achieve no net loss is not a legitimate reason to dismiss the goal. From a natural resource management perspective, it is much more effective to have specific quantitative objectives than to operate in a grey area of unquantified ecological functions, impacts and mitigation techniques.

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2.2 Wetland Compensation Agreement: Eastern Ontario Waste Handling Facility

— Brian Potter, Mike Eckersley, Kevin Loftus, Dan Mansell, Les McCoy and Anda Rungis

In 1991, Ontario Ministry of Natural Resources staff became aware of interest, on the part of an international waste management company, in creating a landfill site in Eastern Ontario that would include part of a provincially significant wetland. The area was considered to be physically appropriate to the siting of such a facility, based in part on the results of hydrogeological studies. For a variety of reasons (soils; existing, legal land uses in the affected part of the wetland; local interest in the project) the area was identified as the preferred site for the facility. It would serve eastern Ontario with central composting, recycling and landfill capacity. In 1997, the original proponent lost interest in the site, and was replaced by an Ontario firm which had an interest in a "regional" landfill operation (one which would have a longer life span than the original operation).

Major Parties

- Provincial government agencies — Ontario Ministry of Natural Resources (OMNR); Ontario Ministry of Municipal Affairs and Housing (OMMAH); Ontario Ministry of the Environment (OMOE)
- Private companies that proposed the landfill development
- Eastern Habitat Joint Venture (EHJV) — North American Waterfowl Management Plan
- Municipal government
- Local conservation authority

Background/Issue

This development proposal created an issue in terms of the province's wetland policy, which states that provincially significant wetlands are to be protected from incompatible development. Provincially significant wetlands are those wetlands that have been identified as significant using the Ontario Wetland Evaluation System.

The affected wetland, which is approximately 1,700 ha in size, was evaluated in 1986 and determined to be provincially significant. Most of the land (94%) is privately owned. The wetland consists of two types — swamp (95%) and marsh (5%). The soils are organic, underlain by clay. Seventy percent of the wetland is palustrine (i.e. absent or intermittent inflow and permanent or intermittent outflow), and the remaining 30% is riverine.

Marsh vegetation consists of herbs, sedges, grasses, and tall shrubs such as willow and dogwood. Swamp communities include those dominated by tall shrubs (willow and alder), and deciduous trees (Trembling Aspen, Red Maple, Tamarack). Ferns, grasses, sedges and mosses are also present. Two provincially significant species were identified in the 1986 evaluation: a plant — the Southern Arrow-wood, and the marsh hawk, or northern harrier. The wetland provides winter cover for wildlife (local deer yard), and supports populations of a number of fur-bearing species, including muskrat, raccoon, beaver, mink and coyote.

The landfill development would result in the complete loss of about 175 ha (or about 10%) of wetland. Virtually the entire wetland has been adversely affected by agricultural drainage. In other areas, wetland features have been completely eliminated as a result of logging, drainage, sod farming and peat extraction. The portion of the wetland under consideration for the landfill operation is also threatened through many of these same activities, all of which are legal under the existing (agricultural) land use designation.

Ministry staff concluded that it made sense in this instance to adopt a flexible approach to wetland management, given that:

- the wetland policy could not prevent ongoing wetland losses (which would eventually have led to the elimination of a portion of the wetland), and provides a degree of control over activities such as land fill operations only as long as the area remains a wetland; and
- the *Planning Act* provides for some flexibility in local planning decisions (i.e. planning authorities are to "have

regard" to the wetland policy and other statements of provincial policy).

The fact that site alterations were legally occurring in the wetland was a major reason for considering a wetland compensation agreement. Another important consideration was the progressive attitude of the development proponent: while fully aware of the limitations of the wetland policy, they were willing to negotiate a compensation agreement, in the interests of being a "good corporate citizen."

Approach to Mitigation

In recognition of the inability of the province's wetland policy to prevent this development in the long term, the physical characteristics of the site, and the support for the facility in eastern Ontario, it was concluded that the best approach was to encourage flexibility in the application of the policy and pursue the proponent's offer to compensate, through negotiations with the proponents and discussions with other agencies.

Prior to entering into negotiations, Ministry staff believed it was important to understand the potential value of the proposed landfill to the proponent. To that end, a chartered accounting firm was hired to evaluate the potential economic value of the waste management operation. Their report assisted in the determination of an appropriate level of compensation. Over a three-year period, OMNR staff negotiated with the proponents and their legal representatives. Negotiations were based on the following principles of compensation, which were developed by the Ministry staff involved in the project:

- Compensation should only be considered when no viable alternative (to allowing some loss of a provincially significant wetland) can be identified. *In this situation, wetland losses were unavoidable.*
- On-site compensation is generally preferred over off-site compensation. Exceptions might occur (a) where better/more wetland values can be protected by selecting an off-site location, or (b) where the long-term integrity/quality of the on-site location is threatened. *Both (a) and (b) apply in this case. (a) Another provincially significant wetland (a nearby bog) was determined to be much more ecologically sensitive and less degraded than the wetland in question. This represents the securement component of the compensation agreement. (b) On-site wetland restoration/creation potential is very limited, given existing land uses. Off-site wetland restoration/creation is feasible.*
- The order for off-site compensation should be adjacent sites, in the same watershed, regionally and then provincially. *The bog identified in the securement component of the agreement is in the same watershed as the affected wetland. Wetland restoration/creation efforts are to be focused in eastern Ontario, as defined in the wetland compensation agreement.*
- The wetland type (swamp, marsh, bog or fen) that is being destroyed should generally be compensated for by replacement with the same wetland type (i.e. marsh replaces marsh, etc.). Exceptions might occur (a) where a relatively common wetland type can be replaced by a less common wetland type and/or (b) where replacement with another wetland type would provide more social/ecological benefits than replacement with the same wetland type. *Both (a) and (b) apply in this case. Compared to marshes and swamps, bogs are extremely rare in southern Ontario. Securement of a portion of a provincially significant bog, will make a significant contribution towards conservation of this rare southern Ontario wetland habitat.*
- Compensation agreements should consider some/all of the following:
  (a) appraised land values (in the case of acquisitions) and/or costs (in the case of restoration/creation projects);
  (b) the amount/quality of wetland that is being "compensated";
  (c) economic benefits that might accrue from the proposed development; and

(d) other factors as appropriate.

Two types of compensation should be negotiated — the commuted natural resource value and the corporate stewardship value. The former is arithmetically derived from items (a) to (d), above. Other factors (d) might include the cost of lost recreational opportunities or the difference between development costs at the selected site and alternate sites. The second type of compensation is additive to the first and is morally based. It varies in each situation and is usually determined through negotiations. ***Both types of compensation were considered in this case.***

The agreement between OMNR and the proponent is in the form of a Memorandum of Understanding (MOU).

Process for Mitigation

Landfill proposals are subject to Ontario's *Environmental Assessment Act* and *Planning Act* approvals (the provincial wetland policy is issued under the authority of the provincial *Planning Act*).

- *Environmental Assessment Act*: Normally, a provincially significant wetland would be eliminated, through the environmental assessment screening process, from consideration as a landfill site. In this situation, however, it remained a candidate since the legal activities occurring on the site (most notably, market gardening, peat extraction, sod farming) eventually would result in the loss of wetland area, at which time the wetland policy would no longer apply.

28 As part of the screening process, OMNR staff reviewed the potential ecological impacts of the landfill proposal on adjacent wetland and fish habitat, and other natural features.

- *Wetland Policy*: Ontario's first wetland policy came into effect in 1992, shortly after discussions on the landfill development began. The policy identified specific goals and objectives for Ontario's wetlands. The objective for that part of Ontario where the landfill development would occur was "to ensure no loss of wetland function or wetland area of provincially significant wetlands." Under the *Planning Act*, planning authorities, including OMNR, must "have regard to" (i.e. seriously consider) the wetland policy, and other statements of provincial interest. In 1992, government direction on implementation of the policy was that it be strictly applied (i.e. "no loss means no loss"). In September of 1992, the waste management company was informed that OMNR would object to any land use changes that did not follow the intent of the wetland policy, and that flexibility to negotiate was very limited. The waste management company continued with its site selection process, within the environmental assessment planning process.

In May 1996 the original Wetlands Policy Statement was replaced with the *Provincial Policy Statement*, in which wetlands policy is a component of the Natural Heritage Policies. Under this current wetlands policy, provincially significant wetlands are to be "protected from incompatible development." In the portion of Ontario located south and east of the Canadian Shield, where wetland losses have been the most severe (up to 95% in some areas), development and site alteration are not permitted in provincially significant wetlands. As was the case with the original wetland policy, planning authorities must "have regard" to the *Provincial Policy Statement*. With the advent of the new wetlands policy, OMNR was directed to be more flexible in applying the policy. This change in direction reflected, in part, recognition that, in some cases, strict application of the policy was resulting in wetland losses. Negotiations with the proponent began in the Spring of 1996.

In terms of the *Environmental Assessment Act* and *Planning Act* approvals, OMNR will advise:

- OMOE that the landfill environmental assessment process meets our concerns regarding wetlands;
- OMMAH that, in terms of *Planning Act* approvals, there are no objections to the landfill proposal.

In agreeing to the landfill proposal and developing the MOU, OMNR considered

the intent of the wetlands policy (protecting wetlands from incompatible development), and sought a net gain of wetland area and functions.

Results

It is important to note that, from a planning perspective, this matter has not been finalized because it has not been through the *Planning Act* process as of May 1999.

Avoidance was not considered to be a viable alternative in this situation. In the absence of a compensation agreement, the wetland would eventually disappear, through legal activities, at which point the wetland policy would no longer apply and OMNR would have no means to protect the wetland.

Minimization of Impacts: Creation of a landfill site would result in the loss of all wetland functions on that piece of land. The MOU stipulates that the wetland area adjacent to the landfill site must be protected from development impacts.

Compensation: To offset the unavoidable loss of 175 ha of wetland, the MOU stipulates that, for every one hectare of wetland lost to the landfill operation, four ha of wetland and associated wildlife habitat are to be secured, enhanced, restored or created.

Specifically, the MOU calls for:

- securement of 400 ha of a nearby, provincially significant wetland, and
- creation of 400 ha of wetland in eastern Ontario.

This translates into a compensation ratio of 4.57:1 (or a net gain of 625 ha of protected and created wetland).

The MOU also stipulates that:

- the agreement will only take effect upon issuance to the Company of the Certificate of Approval (issued by OMOE);
- an independent investment fund ("Trust Fund") be established with the capital and proceeds used for wetland securement, enhancement, restoration or creation in eastern Ontario. "Eastern Ontario" is explicitly defined, to help focus wetland securement and creation efforts.
- the Trust Fund would be administered by a Board of Directors ("The Board"), comprised of representatives from the company operating the landfill ("The Company"), OMNR, and any other groups, agencies or individuals mutually agreed upon by the company and OMNR;
- the Board would take its overall direction from provincial wetlands policy, OMNR's wetlands program, and wetland management plans such as those of the EHJV;
- the Trust Fund would be initiated when the Company reaches an annual operating tonnage of 50,000 tonnes. Thereafter, it would provide the Trust with $1.00 for every tonne handled, up to a total contribution of $1.5 million. During the first five years of operation, the Company would make no contributions to the Trust in any year in which the total tonnage handled is less than 50,000 tonnes, even if the tonnage in any previous year was greater than 50,000 tonnes;
- the Company will provide a financial guarantee of commitment to the Trust agreement;
- with an agreement for the establishment of the Trust Fund, and upon securement of the financial guarantee from the Company, OMNR agrees that, when municipal planning applications related to the landfill proposal are made, they will advise the Ontario Ministry of Municipal Affairs and Housing that OMNR interests relative to the wetland have been addressed;
- the Company may nullify this agreement, with six months' written notice. If this were to occur before the Company provided $1.5 million to the Trust Fund, the Company would immediately upon cancellation of the agreement, pay the Trust Fund an amount equal to the difference between their contributions to that time and $1.5 million;
- the Company may, in any one year, contribute more than the required payment

for that year, based on the tonnage handled. This amount would be applied toward the total contribution of $1.5 million;

- the Trust Fund may accept funds from other sources, to secure, enhance, restore and create wetlands and associated wildlife habitats in eastern Ontario.

Reflections

In terms of positive impacts, the compensation agreement is expected to result in a very clear net benefit for wetlands. Inaction on the part of the provincial government would have resulted in the complete loss of wetland functions on the affected parcel of land, with no recognition of or compensation for lost wetland functions and benefits. The agreement should result in a net gain in wetland area. This is important, since wetland restoration/creation is not an exact science — restored and created wetlands often are not as efficient as natural systems (i.e. one hectare of restored wetland may not provide the same benefits as one hectare of a natural wetland).

Conversely, awareness of the potential for application of a net-gain or no-net-loss approach to wetland protection could lead to an expectation that compensation should be the option of first choice, when in fact it should be the last.

Principles of Compensation: While the principles of compensation that were developed were very useful during the negotiations, it was difficult to identify a principle that, in a defensible manner, helped us determine "how much (compensation) is enough."

Policy Effectiveness: The wetlands policy was effective in the sense that its controls on development provided the means to negotiate a compensation agreement. Conversely, and in a broader sense, the lack of policy/planning controls on activities that can result in wetland loss and degradation (e.g. peat extraction) contributed to the need for a wetland compensation agreement. In other words, if the wetlands policy was more comprehensive, in terms of its controls on land-use activities, a compensation agreement may not have been necessary. The continuing loss of wetland, due to legal land-use activities, is the main reason the wetland remained a candidate landfill site — the wetland would soon disappear, at which point the policy would no longer apply.

Protection of wetlands through the use of policy can be effective if implemented in a comprehensive fashion (i.e. Official Plans, zoning, and site alteration by-laws), but there must be government and societal commitment to do so.

Given that there are limitations on policy protection of wetlands, there is a need to continue to explore other wetland protection mechanisms, such as wetland compensation agreements and wetland legislation.

2.3 Road Through a Wetland: Alberta

— Brett Calverley

The County of Vermilion applied for a permit to build a road grade through a wetland five kilometres north of the Town of Vermilion. This is a typical prairie wetland with maximum depth of one metre. Emergent vegetation covers the entire wetland. The wetland is probably a groundwater recharge site that is valuable for spring runoff retention, uptake of agricultural fertilizers and for wildlife habitat, especially waterfowl. This is a small-scale project, in which a proposed road was to be routed through a shallow prairie wetland.

Major Parties

- Alberta Environmental Protection
- County of Vermilion River

Background/Issue

In the opinion of Alberta Environmental Protection it was determined that mitigation for lost wetland was needed.

Approach to Mitigation

The Wildlife Management Division of Alberta Environmental Protection was consulted for recommendations for mitigation. The aim of the mitigation was to restore the lost wetland values caused by the road crossing. Because the wetlands were closed drainage systems, not contributing to a nearby tributary of the Vermilion River, the most important limitation was deemed to be loss of wildlife habitat.

Process for Mitigation

Under the *Water Resources Act*, the proponent, in this case the County of Vermilion River, must apply to Alberta Environmental Protection for a permit to disturb/partially fill a natural wetland. The application process triggered an inspection, which resulted in the recommendation for mitigation.

Terms of the mitigation were presented to the engineering consultant who acted as the agent for the County of Vermilion by the Environmental Protection, Water Resources Division representative. Initially, four earthfill nesting islands were recommended. However, because there was no basis for recommending four islands, the two parties agreed to build two islands.

Results

Avoidance did not occur; the project proceeded as planned, but with the added cost of mitigation. The road was designed to withstand the effects of standing water on both sides of the right-of-way. There was no attempt to change the design to minimize the effect on the wetland. The road edge was to be seeded with a mixture of grasses and legumes and mowing of this vegetation was to occur only between July 15 and August 15. No fences or overhead power lines were allowed along the road right-of-way to prevent bird collisions/mortality.

Artificial nesting islands were recommended to restore the wetland values to wildlife. Two islands with 10 × 25 metre tops, 0.5 metres above the high water mark and with complete moats a minimum of 5 metres wide were constructed. Islands were seeded with a grass/legume mixture suitable as nesting cover for waterfowl and a variety of other wetland dependent birds. Islands were built as far from shore as possible and suitably spaced (> 100 metres) to maximize use by Canada geese. One dugout was constructed to provide open water in an area of the wetland that was overgrown with emergent vegetation.

All construction (road and mitigations) was conducted while the wetland was dry. Therefore, mitigation costs were kept to a minimum. Mitigation measures incurred 5% of the total construction costs for the wetland crossing.

The rationale for constructing nesting islands and one dugout was to restore wetland productivity back to its pristine state or better. Indeed the placement of secure island nesting sites would result in greater net duck productivity from the wetland than was realized prior to construction. The loss of wetland area and the corresponding loss of breeding pairs of ducks was more than adequately mitigated by improved nesting success of the resulting duck popu-

lation. Furthermore, the construction of the dugout served two purposes: 1) it provided extra borrow material for the road, and 2) it increased breeding pair space in an otherwise overgrown and unused portion of the marsh. The nesting islands also provide nesting sites for Canada geese, which did not nest on the wetland previously, and for a variety of other island-nesting and grassland nesting migratory birds.

Reflections

Overall, wetlands at least "broke even" and probably gained as a result of the mitigation, at least with respect to waterfowl habitat.

The *Water Resources Act* has existed for decades and has always contained a process for mitigating wetland degradation. Actual application of the mitigation process has become more frequent since the *Interim Alberta Wetland Policy* in settled area of the province was adopted in 1993. This interim policy will soon be consolidated under an overall wetland policy for Alberta and open to public consultation now that the new *Alberta Water Act*, 1999, has been implemented.

Certainly some wetland was lost (approximately one hectare). However, the mitigation probably made the wetland more productive for waterfowl than it was prior to the mitigation. The islands were considered adequate compensation for the loss of one hectare of wetland. Because the basin did not have an outlet, it would still store the same amount of spring runoff. By constructing the islands with moats using lakebed material, open water was created in an area overgrown with emergent vegetation. This open water has resulted in increased waterfowl breeding pair space and improved moulting and staging habitat on the wetland.

This is a typical example of a very common wetland impact in Alberta and probably throughout the Prairie Provinces. Similar situations occur dozens of times each year. Under the new *Water Act*, and coupled with the new proposed Wetland Policy For Alberta, not only will the provincial government have a very effective tool for wetland protection but more power to enforce wetland maintenance.

2.4 Rollie's Marsh Enhancement: Prince Edward Island

— Tom Duffy

In 1992 an agreement was signed between the Governments of Canada, Prince Edward Island, New Brunswick and Strait Crossing Development Inc. to construct the 13-kilometre Confederation Bridge between Borden-Carleton, Prince Edward Island, and Cape Jourmain, New Brunswick. Construction began in the fall of 1993 and the bridge opened on schedule on June 1, 1997. This was a massive construction project which employed many unique engineering methods and a novel approach to private-public financing. One little known "first" for P.E.I. was the requirement for Strait Crossing Development Inc. to mitigate for wetland disturbance.

Major Parties

- Strait Crossing Development Inc. (SCDI)
- P.E.I. Department of Environmental Resources (DOER)
- Ducks Unlimited Canada (DUC)

Background/Issue

On November 3, 1993 SCDI requested authorization from the Department of Environmental Resources to infill a 1.6 ha freshwater marsh situated on a site proposed for the bridge's toll plaza. Under P.E.I.'s *Environmental Protection Act*, no person shall alter a wetland or watercourse without a permit issued by the Minister. There is no provision in the Act for mitigation, including compensation, for destroyed habitats.

The wetland to be infilled scored 67.0 out of a possible 105 points on the Golet wetland scale (Dibblee 1990). The wetland consisted of mainly open water (70%) with a cattail edge. It provided habitat to typical P.E.I. wetland species including amphibians such as green frogs, leopard frogs, black ducks, ring necked ducks, blue winged teal, American bittern, blue herons, sora rails, red-winged blackbirds, muskrats and mink. A pair of redhead ducks (uncommon to P.E.I.) was observed on this marsh in 1990.

Approach to Mitigation

Prior to SCDI's request to infill, SCDI staff informally notified DOER staff that they were looking at infilling the marsh as an option for the site of the toll plaza. Staff from SCDI and DOER jointly explored other options to avoid damaging the wetland. However, to meet minimal size requirements for the toll plaza it became apparent that the wetland would have to be infilled. DOER staff then met with personnel from SCDI, Ducks Unlimited Canada and the Canadian Wildlife Service to discuss options for compensation. The parties agreed that an appropriate compensation for the unavoidable loss of the 1.6 ha marsh would be enhancement of a 5.5 ha wetland (later to be named Rollie's Marsh) located 600 metres east of the infilled site.

Results

Rollie's Marsh, given a score of 89.5 on the P.E.I. wetland inventory (1990), consisted of approximately 15-20% open water. The predominant emergent vegetation was cattail. The wetland was linked by a 1.2 metre culvert to the 35.4 ha Noonan's Marsh. The water level on Rollie's Marsh was controlled by a water control structure installed by Ducks Unlimited Canada on Noonan's Marsh. The proposed enhancement work to Rollie's Marsh included excavation of the dense cattail stand, island construction and the installation of a water control structure. The projected cost for the project was $15,000. SCDI staff informally agreed to this project and put the formal process in motion through the November 3, 1993 request to the Minister of Environmental Resources. This request was granted through a Ministerial Order dated December 23, 1993 and included the requirement to carry out wetland enhancement work to the satisfaction of the Department of Environmental Resources. SCDI complied with the order and contracted DUC to complete the enhancement work.

Reflections

The construction of the Confederation Bridge was the most intensively monitored

construction project ever completed on P.E.I. It was the result of this intensive monitoring, supplemented by formal agreements and ministerial orders that resulted in this compensation. For example, in an order signed by the Minister of Environmental Resources on September 17, 1993 that approved the construction and operation of the bridge, one condition was that SCDI be required to identify environmental enhancement opportunities in the construction area. The Order also required SCDI to seek approval from the Department of Environmental Resources before any infilling of wetlands occurred. Thus while avoidance did not occur and no minimization of effects was possible because of the decision to fill the wetland, these orders gave the Minister considerable leverage in specifying compensation for the proposed infilling.

The net environmental effect, however, was the loss of a wetland. Today there is 1.6 ha less wetland habitat in the Borden-Carleton area. The enhanced wetland, Rollie's Marsh, was a site that was evaluated by the North American Waterfowl Management Plan Eastern Habitat Joint Venture (EHJV) staff in 1992 for wetland enhancement. Work on this site did not proceed in 1992 because of the impending bridge construction. Therefore, had the bridge construction not occurred in 1993 it is quite probable that the enhancement carried out by SCDI would have been done by EHJV partners at some point. In reality, denying the request to infill a small freshwater wetland was highly unlikely on this $1 billion project linking P.E.I. to the mainland. Departmental staff are pleased that some form of compensation was available as a result of this project. The challenge now is to use this as a precedent, and apply this compensation principle to other projects when wetland damage is unavoidable.

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2.5 Drain Lake Wetland Mitigation: Nova Scotia

— Reg Melanson

The Nova Scotia 101 Highway, running from Bedford to Yarmouth, is approximately 360 kilometres in length and undivided except for periodic passing lanes. Due to the high volume of traffic this highway receives on a daily basis, a decision was made to twin the highway. This would result in the infilling of wetland habitat in Drain Lake.

Major Parties

- Nova Scotia Department of Transportation and Communications
- Nova Scotia Department of Natural Resources
- Sackville Rivers Association

Background/Issue

In 1992, the first phase of the twinning from Lower Sackville to Mount Uniacke, a distance of nine kilometres, was started. This project resulted in the infilling of approximately 2.2 to 2.5 ha of wetland habitat, as follows: Drain Lake: 0.6-0.9 hectare; Sackville River: 0.8 hectare; Duck Pond (a small marsh): 0.8 hectare. The crossing of the wetlands adjacent to the Sackville River and Duck Pond eliminated one percent of the immediate wetland area and impact was considered to be negligible. Infilling of Drain Lake along the northern edge resulted in a loss of approximately 5% of the lake area, but was not considered to be significant enough to cause a measurable change in lake habitat. However, the section of the lake impacted was extensively used by waterfowl.

The Drain Lake wetland had a score of 73.5 as per the Nova Scotia Wetlands Inventory. The Nova Scotia Wetlands Inventory score measures biodiversity, among other things, and a score of 70 or more is considered to be high. This wetland complex was approximately nine ha in size and consisted of zones of emergent vegetation intermixed with vegetated (submergent) shallow open water, surrounded by fen and shrub swamp. This wetland was acidic, having a pH of 3.8, but very productive, having low diversity but high volumes of macrophytes and invertebrates due to high nutrient input from nearby urban developments. This abundant food supply made the area very attractive to both nesting and staging ring-necked ducks, as well as black ducks, a species whose continental population is in decline.

Approach to Mitigation

The mitigation process was initiated by the Nova Scotia Department of Transportation and Communications. Under the *Nova Scotia Environment Act, Wetlands Directive*, all activities on wetlands greater than two hectares that are a class 1 or 2 undertaking must go through an environmental assessment. Class I undertakings include industrial facilities, mining and related activities, and certain highway construction projects. Class I undertakings may or may not have a significant environmental impact or be of sufficient concern to the public to require an environmental assessment that includes public hearings. Class II undertakings include energy-related activities, major industrial facilities, transportation corridors, and waste management projects. Class II undertakings are considered to have the potential to cause both significant environmental impacts and public concern and therefore require an environmental assessment that automatically includes public hearings.

The Department of Transportation and Communications considered alternate routes, but because this project was the twinning of a highway, limited options were available. Twinning the highway on the other side of the existing road would have meant affecting a larger lake, as well as passing through an area of existing development. The Department determined that the proposed highway alignment would create the fewest environmental problems and be more cost effective than other alternatives. They also decided to compensate for the loss of wetland habitat, and to conduct their activities in a manner that would minimize environmental impacts. The initial aim was to create wetlands or other habitat off-site

to offset the wetland loss resulting from this highway project.

Process

As part of the requirements of the *Environment Act, Wetlands Directive*, the Department of Transportation and Communications conducted an environmental assessment of the Drain Lake wetland. This assessment was carried out by a private consultant and included information on the affected wetland functions and values, including wildlife use. This information was useful in determining the optimal window for performing the work at Drain Lake to minimize impacts.

One option that was initially suggested was that a wetland be constructed in the general area of the affected wetlands, but it was felt this was not a feasible option because there are many wetlands in the general vicinity, and the wildlife value of a constructed wetland in this part of the province would be low because of local soil conditions.

In dealing with the issues, the Department of Transportation and Communications decided to meet with individual groups and agencies separately. Meetings were arranged with the Departmental staff and the consultant to discuss concerns and determine a course of action acceptable to all.

Results

The following mitigation package is the result of these meetings:

Minimization:

1. To minimize the impact of construction, simultaneous dredging and in-filling, combined with a fabric skirt placed around the construction site, resulted in minimal siltation problems.
2. Construction along the lake was carried out in such a way that, although the surface area of the lake was reduced, the productive littoral zone along the lake remained.
3. Water levels in the wetland were controlled by a beaver dam at the outlet. Prior to construction, the beaver dam was removed to maintain water levels at the construction site to a minimum during construction.
4. All activities were carried out in a specified time frame to minimize negative wildlife impacts.

Compensation:

1. The Sackville Rivers Association received $20,000 for enhancement of fisheries habitat in the Sackville River. This money was used for the design and placement of digger logs very close to the impacted site.
2. The Nova Scotia Department of Natural Resources, through the Eastern Habitat Joint Venture, would receive $15,000 towards costs associated with the development of a provincial stewardship strategy. The Department of Transportation also agreed to be a member of the committee charged with developing this strategy.
3. The Nova Scotia Department of Transportation would contribute $5,000/year for three years as a partner in the development and implementation of a biological control program for purple loosestrife and other noxious weeds that would be implemented through the Eastern Habitat Joint Venture.

The total cost of the compensation package to the Department of Transportation was $50,000.

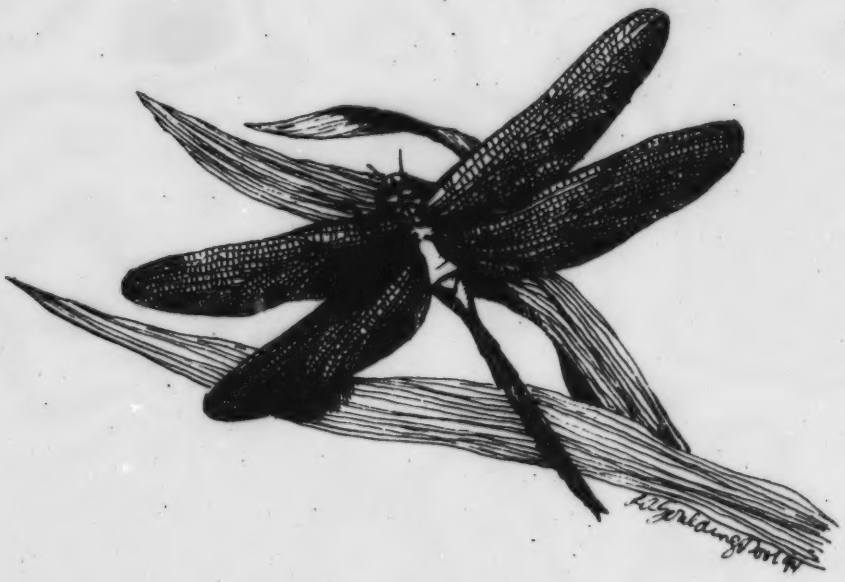
Reflections

This was the first wetland mitigation exercise in the province that was a result of the requirements outlined in the *Environment Act*, which made wetland impact screening by the proponent mandatory. It was a positive and successful experience only partially because of the money that was secured for habitat issues. More importantly, it opened the eyes of both government and non-government agencies alike regarding the value of wetlands.

The wetland mitigation process for Drain Lake established a precedent in the

province within government agencies that wetland degradation, regardless of whether it is being carried out by public or private agencies, will have repercussions. The process also created dialogue on a subject, wetland conservation, that had not been previously discussed between two government agencies. These results may have played a role in other recent decisions, concerning the alignment of the recently built Highway 104 and a natural gas pipeline. Both of these proposed alignments were changed due to the presence of wetlands.

Overall, there was a small, direct physical loss of wetland in an area that does not lack wetlands. It would appear that there is minimal immediate and permanent negative impact from highway construction to the remaining wetlands, and the benefits that resulted from the process appear to be significant.



2.6 Grand Lake Meadows: Negotiating a Mitigation Agreement for a NAWMP Project Site

— Pauline Lynch-Stewart and Kenneth W. Cox

A proposal to re-route a section of the Trans-Canada Highway through Grand Lake Meadows in south-central New Brunswick attracted much attention across North America. Grand Lake Meadows is one of the most ecologically significant freshwater wetlands in Atlantic Canada, and a flagship project site of the North American Waterfowl Management Plan. The Trans-Canada Highway proposal marked the first time that a Plan site was threatened by a major development. The process of mitigating impacts on the Plan's Grand Lake Meadows project was under intense scrutiny, as Canadian partners expressed concern over the future of the Plan in New Brunswick and possible implications elsewhere in Canada.

Major Parties

- New Brunswick Department of Transportation — Project proponent.
- Technical Review Committee — Appointed to advise the New Brunswick Department of the Environment on the environmental assessment of the project. Included Representatives from the following agencies: Government of New Brunswick (Departments of the Environment, Natural Resources and Energy, Health and Community Services, Municipalities, Culture and Housing, Agriculture and Rural Development, Fisheries and Aquaculture); Government of Canada (Environment Canada, Fisheries and Oceans Canada, National Defence, Transport Canada); New Brunswick Museum.
- Eastern Habitat Joint Venture of the North American Waterfowl Management Plan — Project partners in Grand Lake Meadows.
- North American Wetlands Conservation Council (Canada) — Member of Negotiating Team representing Eastern Habitat Joint Venture interests in Grand Lake Meadows.

Background/Issue

Grand Lake Meadows is the largest freshwater marsh in New Brunswick, comprising 5,000 ha of floodplain habitat in the lower Saint John River valley. The Meadows area contains agricultural land in the south along the Saint John River, bordered by hardwood and mixed stands, and a relatively undisturbed meadow/marsh complex extending to Grand Lake to the north. More than 85% of the area is seasonally flooded by the Saint John River during the annual spring flood.

Grand Lake Meadows supports a diverse and thriving biological community. Situated on the Atlantic Flyway, the Meadows host thousands of migrating waterfowl every Spring and Fall. Osprey, eagles and Great Blue Herons reside in the area, which is also popular with moose, deer, bear, coyote, bobcat, fox, beaver, muskrat and other small mammals. Reptiles and amphibians are common, as are fish species such as chain pickerel, perch, eels and smallmouth bass in the waters adjacent to the Meadows. The area provides habitat for the rare buttonbush plant and yellow rails, and it is the only location in New Brunswick where ash swamp is known to occur. In addition to supporting rare species, Grand Lake Meadows also provides flood protection, erosion control, water filtering and purification. The Meadows also attract many recreationists from the region for boating, fishing, hunting, fiddlehead picking and bird watching.

Grand Lake Meadows has long been recognized as a wetland of regional, provincial, national and international importance. The New Brunswick government identified Grand Lake Meadows as an Environmentally Significant Area in 1990. The Meadows area has long been a candidate for designation as a Wetland of International Importance under the Ramsar Convention.

Of most significance to this case study is the status of Grand Lake Meadows as a pro-

je.t site of the North American Waterfowl Management Plan. The Government of New Brunswick chose the Meadows in 1988 as its "flagship" project area under the Plan. Canadian and U.S. partners, under the aegis of the Plan's Eastern Habitat Joint Venture, have since contributed more than $1 million to wetland conservation in Grand Lake Meadows — securing 3,050 hectares or 60% of the area of the Meadows. The Government of New Brunswick took possession of these Meadow properties and managed them on behalf of the Plan partners. All Plan contracts and agreements by partner agencies require that properties be maintained for wetland conservation, or the funds must be returned to the donor.

In 1993, the New Brunswick Department of Transportation proposed construction of a new four-lane section of the Trans-Canada Highway between Fredericton and Salisbury. The project was part of an overall plan to upgrade New Brunswick's Trans-Canada route to national transportation standards. The Department's preferred route for the new highway, based on constraint mapping, cost-benefit analysis and phased development opportunities, traversed the eastern end of the Grand Lake Meadows. The Grand Lake Meadows section of the new highway — some 6 km in length — was proposed as an earth/rockfill embankment approximately 100 metres in width, and a bridge over the Jemseg River. The existing highway would become a collector highway, and traffic volumes on the new Grand Lake Meadows section were estimated at almost 5,000 vehicles per day including 800 trucks.

Approach to Mitigation

Environmental Impact Assessment Under New Brunswick's *Clean Environment Act*

The Fredericton to Salisbury highway upgrade project was subjected to a provincial environmental impact assessment under New Brunswick's *Clean Environment Act*. The assessment was conducted on behalf of the New Brunswick Department of Transportation by a consulting firm, during the period from 1993-1996. The New Brunswick Department of the Environment established a federal-provincial interdepartmental Technical Review Committee to provide guidance and review the assessment. A federal environmental assessment was not conducted because New Brunswick did not seek funding for the highway from Transport Canada.

In March 1996, the New Brunswick Minister of the Environment accepted the final report *Environmental Impact Assessment Trans-Canada Highway Fredericton to Salisbury* (Washburn & Gillis Associates Ltd. 1996) "as a satisfactory document on which to base a public discussion of the proposal and its potential for project related environmental impacts." The report concluded that "with the implementation of appropriate mitigation strategies, no significant bio-physical or socio-economic impacts are predicted as a result of the construction and operation of the Trans-Canada Highway along the proposed routing." The Component Study Report focusing on Grand Lake Meadows concluded that "the greatest potential environmental impact to the wetland would occur if construction and operation of the highway significantly altered the hydrology of the Grand Lake Meadows, by prolonging the duration of, or significantly changing the amplitude of spring flood events" associated with the Saint John River. The Study Report focusing on hydrotechnical issues determined that "proper design specifications would ensure no significant change in this flood regime."

A *General Review Statement* released in March 1996 (New Brunswick Department of the Environment 1996a) summarized the opinions of the Technical Review Committee regarding the environmental assessment. The *Statement* indicated that although the Committee was unable to fully determine the significance of impacts on Grand Lake Meadows based on the environmental assessment report, the impact of the Highway on the values and functions of the wetlands and wildlife habitats could be classed as not significant provided that the Highway design ensured minimal impact on hydrology. Further, the *Statement* indicated that development of a

compensatory mitigation plan for Grand Lake Meadows would require more detailed functional analysis of the wetlands and would consider "the requirement to sustain the EHJV program."

A number of scientists and others expressed major concerns about the conclusions of the impact assessment and the *General Review Statement*. In March 1996, Fisheries and Oceans Canada commented that "the impacts of this project on the aquatic resource cannot be fully determined until the final design stage of this project" (Fisheries and Oceans Canada 1996). That same month, the *Saint John Telegraph-Journal* warned that the Meadows "will be seriously endangered if the preferred Highway route is adopted...and we cannot afford the loss" (Saint John Telegraph-Journal 1996). The *Fredericton Daily Gleaner* reported that "some environmental groups are concerned that the Meadows could be severely damaged or altered by the highway" (Fredericton Daily Gleaner 1996). In April 1996, Environment Canada staff wrote that the environmental assessment "does not adequately address the impacts of the highway on wetland function within the Grand Lake Meadows, nor does it address the implications to the North American Waterfowl Management Plan" (Environment Canada 1996).

Public meetings were scheduled for May 1996 to discuss the environmental assessment report. A number of citizens and groups made submissions expressing concern about the environmental impact of the highway on Grand Lake Meadows. Kenneth W. Cox of the North American Wetlands Conservation Council (Canada), made a presentation on behalf of the Partners in the Eastern Habitat Joint Venture of the North American Waterfowl Management Plan (EHJV 1996(f)). The presentation featured the results of an independent review of the provincial environmental assessment documentation related to the Grand Lake Meadows wetland. Major points of that presentation follow:

- The EHJV Board has serious concerns over the content and thoroughness of the environmental impact assessment report. As proposed, the highway development would have significant impacts on the Grand Lake Meadow wetlands. The assessment does not adequately consider the consequences of severing more than 100 ha from the main wetland; the combined effects of visual disturbance, noise, changes in hydrology and chemical contamination; and restricted wildlife movements along the highway.

- Mitigation first and foremost means design and planning to avoid and minimize impacts and, as a last resort, compensation for unresolved impacts on the environment.

- Mitigation measures have not been dealt with adequately in the report. Mitigation has spatial, temporal and financial aspects...purchase of unsecured acres will not compensate for functional losses.

- The environmental assessment too readily relies on mitigation to dismiss the significance of wetland impacts. The assessment should have fully and clearly demonstrated the actual effects of the proposed project on the wetlands' functions and values and should not have used the possible off-setting benefits of mitigation to obscure the significance of those impacts.

- In view of the significance of Grand Lake Meadows as a flagship project of the Plan with substantial contributions from U.S. partners, it is feared that the proposed development could seriously jeopardize future conservation projects.

Despite these expressions of concern, the Government of New Brunswick approved the Highway routing in June 1996, subject to development of a compensation and mitigation plan to address wetland function loss. The Government intended to quantify wetland functions and estimated changes to these functions as a result of the proposed project during the development of the mitigation strategy. The project would directly impact an estimated 55 ha of habitat (lost to the right of way) in the

Grand Lake Meadows area, and directly affect lands that were under conservation agreement between the Government of New Brunswick and EHJV partners. The EHJV wrote to the Government of New Brunswick in July 1996 reiterating outstanding concerns and informing the government that their "preferred approach now is to work towards a fair and comprehensive mitigation-compensation package based upon the loss and destruction of wetlands and decreases in, or loss of, various wetland functions."

Negotiations Between the EHJV and the Government of New Brunswick

The Eastern Habitat Joint Venture outlined a strong, decisive and determined strategy for negotiating mitigation at Grand Lake Meadows (EHJV 1996 (a)(b)(c)(d)(e)). Their approach emphasized a proactive program of avoiding and minimizing impacts through highway planning and design. It focused on maintaining wetland functions and values in the Meadows, and on the need to satisfy all Canadian and American partners involved in the Grand Lake Meadows project. The main elements of their opening position included:

- Rerouting of the Trans-Canada Highway through Grand Lake Meadows will have severe impacts on the Meadow directly and potentially on the future of EHJV programs throughout the Province and negative implications on Plan delivery internationally. An adequate mitigation and compensation package must be negotiated that totally satisfies the contractual arrangements of all EHJV partners, and is individually approved by partner agencies.
- Mitigation and compensation of wetland destruction and loss of wetland function within the project site are a minimum preferred option to payback to partner agencies.
- A number of options are available to the developers that will help mitigate against adverse effects of constructing the highway through the Grand Lake Meadows:
  - *Highway design* — as much of the highway as possible should be elevated as opposed to filled. Filled portions must have frequent culverts to maximize exchange of water between the main Grand Lake Meadows and the severed portion of the wetland;
  - *Wildlife travelways* — final design should enable wildlife movements to the highest degree possible;
  - *Review of design* — the Board requires an opportunity to review and approve the final highway construction design through Grand Lake Meadows prior to implementation;
  - *On-site inspector* — to ensure that design specifications are followed; and
  - *Post $2 million bond* — to cover future modifications if monitoring determines that modifications are necessary should the hydrology be impacted or wildlife travelways be impeded. The bond could also serve as a source of payback funding to any partner agency that disagrees with the compensation/mitigation plan that was negotiated by the Board.
- Compensation is requested for:
  - *Direct loss* of wetland values and functions as a result of destroying wetlands in the footprint of the highway — by restoring an equal or higher quality habitat;
  - *Loss of wetland function* due to disturbance adjacent to the highway, impacts on wildlife travelways, effects of light and potential for contamination along with the impact of severing over 100 ha of wetlands from the main body of the Grand Lake Meadows; and
  - *Loss of socio-economic values* due to loss of access from the new highway for hunting, fishing, fiddlehead picking and nature interpretation.

The Government of New Brunswick responded to this position with a systematic assessment of wetland functions and values in Grand Lake Meadows. Although the quantification of wetland functions and values was intended to be addressed at this

stage of the project planning, the Technical Review Committee decided that further quantification of potential impacts was unnecessary and therefore efforts would focus on identifying and prioritizing the functions and values of habitats to be impacted. This was based on two considerations: that "the measurement of potential impacts is a somewhat inexact science," and "development of appropriate compensation for habitat loss will result from a negotiation process with interested parties" (Government of New Brunswick 1996).

The assessment of wetland functions and values, contained in the report *Summary of Potential Impacts to Wetlands Function and Mechanisms of Mitigation/ Compensation at Grand Lake Meadows* (Government of New Brunswick 1996), described in relative, qualitative terms, the importance of each value in Grand Lake Meadows and the degree of impact on each value in the Meadows and in the right of way. The assessment also recommended whether residual losses needed to be considered in the mitigation strategy. The assessment was based on the Component Study Report on Grand Lake Meadows completed for the *Environmental Impact Assessment Trans-Canada Highway Fredericton to Salisbury* (Washburn & Gillis 1996), and the *Wetland Evaluation Guide* (Bond *et al.* 1992), and existing knowledge. Table 2.1 shows the results of this assessment for one set of wetland values. An assessment was also completed for the following groups of wetland values:

- Life support: hydrological, biogeochemical, habitat, ecological
- Social/cultural: aesthetic, recreational, education and public awareness, cultural attribute values
- Wetland production: agricultural, renewable resource values

Process of Negotiating a Mitigation Agreement

Based on the approach described above, the EHJV and the Government of New Brunswick negotiated a mutually satisfactory mitigation package between October 1996 and July 1997. The main items of the package served as the basis of an agreement signed between the Chair of the EHJV and a representative of the New Brunswick Department of Transportation in May 1998. This section outlines the main steps of that process.

In early October, 1996, the Board of the EHJV appointed a team to negotiate a deal with the New Brunswick Department of Transportation for the loss of wetland function. The team developed a negotiation strategy, process and position, in consultation with the Board and with advice from NAWMP partners who successfully negotiated a settlement in the case of the Vancouver International Airport runway expansion. The Board decided that U.S. partners would not be involved in the negotiations, but would be informed of the negotiated package once it was finalized.

The first meeting of the EHJV negotiating team and the Department of Transportation was held on October 30, 1996. The EHJV outlined their position, and the Government of New Brunswick indicated agreement in principle with many of the key requirements. Negotiations were aided by the fact that several of the representatives of the Government of New Brunswick had participated in 1995 in a wetland evaluation training course presented by the North American Wetlands Conservation Council (Canada).

In the month following the initial meeting, the Government of New Brunswick prepared the *Summary of Potential Impacts to Wetlands Function and Mechanisms of Mitigation/ Compensation at Grand Lake Meadows* (Government of New Brunswick 1996). As described in the "Approach" section of this case study, the *Summary* featured a table that identified and prioritized wetland functions and values, and described potential impacts resulting from the project proposal. The *Summary* also compared the conclusions in the table to the EHJV mitigation proposal tabled at the October 30 meeting, and suggested modifications to that original position.

For the next eight months, negotiations were carried out through exchanging

Table 2.1
SAMPLE ASSESSMENT OF WETLAND VALUES

Wetland Values	Relative importance in GLM as whole	Significance in GLM complex as whole	Significance in ROW	Degree of impact in GLM	Degree of impact in ROW	Need for consideration in mitigation strategy
Hydrological Values						
• Provides flood protection benefits	high	yes	no	low-nil	NA	highway design as per recommendations of hydrotechnical study should mitigate these impacts
• Contributes to usable surface water	medium	yes	no	low-nil		
• Provides erosion control	medium	yes	no	low-nil		
• Reduces tidal impacts	low	yes	no	low-nil		

(Source: Government of New Brunswick 1996)

drafts, teleconferencing and meetings, resulting in a final *Mitigation and Compensation Plan for Wetland Function Loss* (Government of New Brunswick 1997) completed in July 1997. The strategy considered two key areas of impact: habitat and life-support functions, and social/cultural functions and values. Details are presented in the Results section.

In May 1998, a Memorandum of Understanding was signed between the Province of New Brunswick Minister of Transportation and EHJV "for mitigation and compensation of potential impacts of highway development to the Eastern Habitat Joint Venture, Grand Lake Meadows Project," as per the *Mitigation and Compensation Plan for Wetland Function Loss* (Government of New Brunswick 1997). Also in May 1998, Ducks Unlimited Canada signed an agreement with the Province of New Brunswick acknowledging that the *Mitigation and Compensation Plan* compensates for impacts of the highway development to the EHJV Grand Lake Meadows project, and consenting to the transfer of lands to the Department of Transportation for construction of the highway.

Results

The agreement to mitigate the impact of the construction and operation of the Trans-Canada Highway on the EHJV Grand Lake Meadows project contained provisions for wildlife support and social/cultural functions. The main elements of the *Mitigation and Compensation Plan for Wetland Function Loss* (Government of New Brunswick 1997) are described below.

Wildlife Support

Habitat will be directly lost within the highway right-of-way. Wildlife support functions on this lost habitat will be compensated through acquisition of privately-held habitat within the Grand Lake Meadows and acquisition of habitat for restoration within the Saint John River Floodplain ecosystem.

The acquisition formula is consistent with compensation rates applied in similar situations elsewhere in North America:

A. Acquisition, restoration and protection of habitat outside Grand Lake Meadows, at a ratio of 3:1 (three ha

acquired for every hectare lost).
  - Based on 55 ha being lost, this could result in a maximum of 165 ha acquired if Part B is not pursued, or a maximum of 82.5 ha if Part B is realized in full.

B. Acquisition and dedication of privately-held habitat within Grand Lake Meadows for conservation purposes at a ratio of 10:1 (ten ha acquired for every hectare lost) to a maximum of 50% of the compensation package.
  - This would result in a maximum of 275 ha acquired. If Part B is realized in full, the result would be a maximum of 357.5 new ha acquired.

These acquisitions are to be carried out by the New Brunswick Department of Transportation within a four-year period. If the acquisition goals cannot be met, then the Department of Transportation will provide funding for wetland acquisition and restoration on the basis of $2,500 per hectare for the balance of the 55 ha not compensated for under the ratios set out above. If funds exist due to a shortfall of land acquisition at the end of the four-year period, these funds will be paid to the New Brunswick Department of Natural Resources and Energy to be managed for wetland conservation.

Specific protection and monitoring measures are required of the project proponents to ensure that impacts do not occur outside the footprint area. However, in light of any potential for impact outside the right-of-way, the New Brunswick Department of Transportation will acquire an additional 55 ha of privately-held habitat within the Grand Lake Meadows to be dedicated for conservation purposes.

Other specific wildlife impacts will be mitigated by the following:
- Culverts will be designed to provide travel corridors for small wildlife;
- Re-establishment of buttonbush colonies occurring along the right-of-way;
- Establishment of six osprey nesting platforms within the Grand Lake Meadows; and
- Changing the design slope from 5:1 to 2:1 with a guard rail, to reduce the footprint of the roadbed and discourage mammals from accessing the road.

Protection and monitoring measures designed to maintain the hydrologic regime will also be required of the project proponents. Independent auditors will ensure compliance with the environmental protection and monitoring measures.

Social/Cultural Values

The Grand Lake Meadows Fund will be established and held in trust through the New Brunswick Wildlife Trust Fund for use by the Grand Lake Meadows Project Management Committee. The Committee will be responsible for developing appropriate compensation activities and programs with the funds provided.

The New Brunswick Department of Transportation will provide an initial sum of $200,000 to the Trust Fund. The Department will provide additional funding up to a maximum of $300,000 provided the Committee provides matching dollars through other government programs or private sector partnerships. This additional $300,000 is available for a ten-year period.

Progress

The first cheque of $350,000 was presented to the Minister of Natural Resources and Energy to be placed in the Grand Lake Meadows Fund. Over the next three years an additional $450,000 will be deposited to this account for a total of $800,000 to be used to mitigate social/cultural functions and values. This account will be managed by the Grand Lake Meadows Project Management Committee, which was established in the spring of 1999. The Committee includes representatives from the partners of the EHJV as well as other interest groups and stakeholders. Committee guidelines indicate that the funds are to be used for projects such as the development of low impact public access and interpretation facilities, low impact educational facilities and programs, and wetland research and management projects.

Land acquisition under the mitigation and compensation plan has been ongoing. The Department of Transportation has purchased 320 ha of the 412 ha required under the mitigation and compensation plan and they have up to 2001 to acquire all of the land, or provide funding for habitat not replaced through acquisition.

Six osprey nesting platforms have been built and installed during the fall of 1997 along the Grand Lake Meadows. Ospreys are currently using all of these platforms.

The Maritime Road Development Corporation, a consortium of companies granted the contract to build this road, was awarded the Environmental Achievement Award for 1998 by the Transportation Association of Canada. The Environmental Management Plan developed for the highway set standards for construction that were higher than those normally applied to projects in the province.

Reflections

One of the most surprising aspects of the construction of the Trans Canada Highway through Grand Lake Meadows is that a federal environmental assessment was not triggered. This assessment should have been triggered by a number of factors: Environment Canada dollars were part of this NAWMP project, fisheries habitat was being impacted and the *Federal Policy on Wetland Conservation* (Government of Canada 1991) should have been respected. However, the section of the new highway traversing the Grand Lake Meadows was funded through a provincial/private funding consortium, thus taking pressure off the process to elicit a federal assessment. Partners in the North American Waterfowl Management Plan feel that federal assessment and approval should have been required because of the Government of Canada's substantial investment in environmental conservation and restoration in the Grand Lake Meadows site under the Plan. This apparent gap in the federal approvals process should be explored further.

The *Mitigation and Compensation Plan* was not designed on the basis of a detailed, quantitative, scientific assessment of the habitat, hydrological and water quality functions of Grand Lake Meadows, and changes to these functions as a result of the proposed project. Rather, the *Plan* was developed on the basis of qualitative assessments of wetland functions and in consideration of compensation precedents elsewhere in North America. The main reason for this qualitative approach to mitigation planning at Grand Lake Meadows was our limited scientific understanding of wetland functions and relative inexperience in Canada in measuring and evaluating them.

The Grand Lake Meadows approach highlights one of the major challenges in mitigating impacts on wetlands in Canada: functional assessment. Despite the emphasis in Canadian wetland policies at the federal and provincial levels on maintaining functions, and the technical advances made in this area in the United States, Canada lags behind in developing and applying wetland functional assessment methodologies for regional planning, environmental assessments, and environmental restoration strategies. In recognition of our limitations in functional assessment, the Grand Lake Meadows Fund will be partially devoted to supporting long-term monitoring and assessment of wetland functions on the site, to contribute to the scientific underpinnings of future mitigation initiatives.

Negotiations between the EHJV and the Government of New Brunswick on the Grand Lake Meadows issue demonstrate the challenge of partnerships, and particularly the conflicting roles that government biologists and decision-makers are sometimes expected to play. On the one hand, the Province of New Brunswick is a partner in the North American Waterfowl Management Plan. As such, individuals in the natural resources department have worked for more than a decade to secure, restore and enhance wetlands in the Grand Lake Meadows project site, under agreements that call for long-term conservation of those properties. On the other hand, these same individuals were suddenly required to represent the Government of New Brunswick as the proponents of a

highway planned to traverse the Plan project site. Considering the difficult position these individuals were placed in as a result of the decision to route the highway through the Grand Lake Meadows, their efforts and the resulting mitigation agreement were commendable.

Pat Kehoe, then of the New Brunswick Department of Natural Resources and Energy, was a member of the negotiating team. "I am proud of the process and results that were achieved in the negotiation of mitigation for impacts on Grand Lake Meadows. I feel that a fair deal was reached." Kehoe considers that the most novel aspect of the deal was the compensation for social/cultural impacts. However, says Kehoe: "If I had to do it again I would award the compensation dollars to an established group, such as Ducks Unlimited, or a local conservation authority, instead of trying to create a new management committee to administer the funds. The main reason a government agency was not considered was due to the problems with establishing an on-going trust fund within the government's budgetary structure." He points out that in future cases, the negotiating team should establish strong terms of reference for the compensation fund prior to the dollars being awarded. In the Grand Lake Meadows case, these terms of reference were not established prior to the agreement being finalized.

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2.7 Vancouver International Airport Runway Expansion: Delivering a Compensation Program Aimed at No Net Loss of Habitat Functions

— Pauline Lynch-Stewart

Construction of a third runway at the Vancouver International Airport represents the first major project in Canada that aims to achieve no net loss of wetland and upland habitat functions. Up to the time of the environmental assessment of the Airport runway expansion, "no net loss" was a principle common only to the conservation of fish habitat in this country. Environment Canada promoted application of this principle to the runway project to demonstrate one approach to "making sustainable development work" in the third largest and fastest growing region in Canada. The resulting mitigation program serves to set important precedents and teach valuable lessons about achieving habitat conservation in the context of sustainable development.

This case study focuses on one particular aspect of the mitigation efforts related to the Airport runway expansion — the design and delivery of a habitat compensation strategy.

Major Parties

- Transport Canada — Project proponent; responsible for supporting the cost of mitigating the impacts of the Airport runway expansion.
- Environment Canada — Made formal presentations to the Environmental Assessment and Review Panel hearings on the project; negotiated the details of the habitat compensation strategy with Transport Canada; continues to lead the implementation and monitoring of the habitat compensation program on behalf of the Government of Canada.
- Wildlife Habitat Advisory Committee on Compensation — Advises Environment Canada and Transport Canada on the habitat compensation strategy; contributes to implementation of the habitat compensation program.

Background/Issue

The Fraser River delta is a vital staging and overwintering area for millions of migrating birds, including the largest wintering densities of raptors and Great Blue Herons in Canada. Sea Island is an integral part of the Fraser River delta ecosystem and also home to Vancouver International Airport.

In the 1980s, Transport Canada proposed construction of a third runway at the Airport. The department predicted that: "The $100-million project would deliver an estimated $3 billion worth of economic benefits to British Columbia. The Airport already sustains more than 30,000 jobs, and contributes $2.7 billion to the provincial economy. Forecasts for the decade show the Airport will experience strong growth and every increase of 10,000 passengers will bring 52 person-years of employment and $9 million in additional revenue." (Transport Canada Minister's Office 1992).

Environmentally, one of the major issues was that the runway would result in the loss of approximately 350 ha of wetland and upland wildlife habitat — mostly hay field, wet pasture, old field, ditches and hedgerows that were home to raptors, herons, song birds, shorebirds and waterfowl. Reports noted that "the diversity and abundance of passerine birds using the woodlots and open fields makes this vital area very popular with naturalists."

Approach to Mitigation

Federal Environmental Assessment and Review Process Panel

In 1989, a Federal Environmental Assessment and Review Process (EARP) Panel was charged with reviewing the environmental and socio-economic effects associated with Transport Canada's proposal to construct a new runway at the Airport. A number of parties intervened in the Panel hearings to make a strong case for conservation of the important Sea Island habitat, including Environment Canada, environmental non-government organizations, a local Aboriginal community and numerous individuals. The Panel considered all mitigation options, conclud-

ing that the project was necessary and there were no alternatives, that measures were required to reduce or eliminate some impacts, and that residual impacts were justified but required compensation. The Panel recommended that the runway proceed, but made 22 recommendations about impact mitigation. Pertaining to habitat loss, the Panel reiterated many of Environment Canada's recommendations concerning the no net loss principle and the compensation approach, and recommended that:

- Compensation be made for all loss of habitat and habitat quality, preferably in the vicinity of Sea Island ("on a one-to-one basis" with compensatory habitat having a similar function and quality to habitat lost on Sea Island); alternatively, in Roberts Bank ("on a two-for-one basis"), or Boundary Bay ("on a three-for-one basis").
- Compensation be in the form of purchase and enhancement of land — or through forms of tenure, with enhancement;
- The area north of the runway be set aside as the core of a Sea Island Conservation Area, and that credit be granted for enhancement that increases the area's carrying capacity for selected species of waterfowl, passerines and raptors;
- A survey of birds be conducted prior to any construction and at regular intervals thereafter to ensure the effectiveness of compensation strategies; and
- A Wildlife Management Committee be established to manage the Sea Island Conservation Area for at least 50 years.

Government of Canada Response to Panel Recommendations

The Government of Canada accepted most of the Panel's recommendations. In 1992, the Minister of Transport announced federal government approval to proceed with the runway project. The project was to exemplify the government's approach to sustainable development: "We have taken a reasonable and responsible approach to integrating the environmental concerns and economic benefits associated with the Vancouver runway project." (Transport Canada Minister's Office 1992).

In response to the EARP Panel recommendations, and on the advice of Environment Canada, the government committed to protecting or replacing wildlife habitat to achieve "no net loss of habitat capability" within the Fraser River delta ecosystem. Environment Canada and Transport Canada agreed to compensate for the loss of 350 ha of habitat through land transfers and funding for enhancement and securement activities. Transport Canada committed to working toward conservation objectives while ensuring that aviation safety was not compromised.

The Canadian Wildlife Service (CWS) of Environment Canada continues to be responsible for leading the habitat compensation program on behalf of the Government of Canada, with funding by Transport Canada. In turn, the CWS recognized that long-term success of the program depended on the participation of a diverse group of stakeholders.

Wildlife Habitat Advisory Committee on Compensation

In 1992, CWS established the Wildlife Habitat Advisory Committee on Compensation ("the Committee") to advise and guide Environment Canada and Transport Canada on the compensation program. The Committee comprises representatives of federal and provincial wildlife agencies, a local Aboriginal community, the municipality, the Vancouver International Airport Authority, the provincial ministry of agriculture, a naturalist group, aviation safety experts, and two local community organizations. Led by the Canadian Wildlife Service of Environment Canada, the *Parallel Runway Wildlife Habitat Compensation Strategy* (Wildlife Habitat Advisory Committee on Compensation 1993) was completed in 1993. The *Compensation Strategy* benefited from the views of these constituencies and was fully endorsed by all Committee members.

The *Compensation Strategy* is anchored by a number of statements that define the group's approach to compensation.

- ***Compensation for lost habitat should only be used if the loss of the habitat has been deemed acceptable and unavoidable, and all possible measures to reduce or eliminate impacts have been implemented.***

  In the case of the Vancouver Airport runway project, the Government of Canada made the decision to proceed with the project. As recommended by the Panel, all efforts were made by the project proponents to minimize the damage to the natural environment. Compensation was used as a last resort after all other mitigation was applied and failed to prevent all habitat losses.

- ***The most practical approach to compensation is to try to achieve no net loss of habitat functions and values.***

  The functional approach to habitat management or compensation focuses on maintaining the overall carrying capacity of the landscape for the range of species that inhabit it. When human development displaces other species from an area, the functional approach seeks to *increase the overall carrying capacity of other habitats* to maintain species diversity and populations in the landscape. This approach challenges conservation biologists to assess the habitat requirements for displaced species, and enhance other places to provide these requirements, without displacing species that already depend on that place for survival. The functional approach represents a marked improvement over traditional compensation methods that focused on "replacing habitat on a 1:1 basis" (area of replacement habitat : area of lost habitat), which sometimes improved the habitat for one species *at the expense of others*, resulting in a net habitat loss.

- ***Accordingly, compensation requires an assessment of functions and values of the habitat prior to development.***

  Information should be collected on pre-construction numbers and species of birds, types and functions of habitats, and presence of rare, threatened, and/or endangered species of flora and fauna. This baseline is critical to designing an adequate program and evaluating success.

- ***Simple purchase or preservation of like habitat would not achieve no net loss unless the replacement lands were enhanced to make up for the lost habitat.***

  Assuming that existing habitat in a landscape is already at or close to carrying capacity, compensation by simple purchase or protection of land will result in a net loss of habitat from the landscape and ultimately a loss of wildlife. Unless enhanced, protected habitat will not likely be able to meet the requirements of the displaced wildlife.

- ***Enhancement of the types of habitats required by the displaced species should be carried out without any significant loss of existing wildlife values.***

  Enhancement sites have their own complement of flora and fauna that must not be lost when increasing the land's capability to support additional species and individuals. This limits the type and amount of enhancement that can take place per hectare of land.

- ***To conserve habitats in perpetuity, various methods need to be employed, from strictly protected sites to stewardship of private lands managed for multiple use.***

  No net loss of habitat capability is most likely to be achieved through a combination of securement, enhancement of secured properties, and stewardship on private lands. The promotion of good land planning and management practices on private

lands is just as important as acquisition of small pockets of habitat, to ensuring long-term benefits to wildlife on the landscape. A healthy working landscape, interspersed with areas of natural habitat, can best accommodate the diverse daily and seasonal habitat requirements of a range of wildlife species.

- ***Ensuring that farming remains viable over a large portion of the delta is essential.***

  Many species depend, in part, on farmland for their survival. It is not one or two particular pieces of land that are critical for overwintering birds in the Fraser delta, but the ecosystem or landscape as a whole, with its mosaic of habitat types.

- ***Compensatory lands should be located as geographically close to the lost habitat as possible, should be as ecologically similar to the lost habitat as possible, and have good enhancement potential.***

  Also, compensation for lost habitat should ideally occur prior to development.

- ***Evaluation is regarded as a critical component of the compensation program.***

  First, *a priori* evaluation of the merits of enhancement and stewardship proposals will promote optimal allocation of the resources available for compensation. Second, *a posteriori* assessment of the success of individual enhancement and stewardship projects will reveal the strengths and weaknesses of different strategies of resource management and, thereby, improve future endeavours. Third, assessing progress toward no net loss of habitat capability will indicate when or whether the lost habitat is adequately compensated.

- ***Despite the lack of knowledge and information about implementing the no net loss principle, dedication to the principle is commendable.***

  Adopting the no let loss principle indicates not only an acknowledgement of the importance of wildlife habitat, but a commitment to provide a means to try to compensate for unavoidable habitat destruction and alteration. With each new application of the no net loss principle, we will move closer to solving the problems.

Approach to Compensation

The Airport Authority made a substantial investment in minimizing the impacts of the runway on habitat and wildlife, including transplanting vegetation and creating nesting sites such as perch poles, etc. The Authority also invested in an assessment of the functions and values of the habitat prior to development: analyzing total acreage and types of habitat lost, and conducting field surveys to assess wildlife use in the area planned for development. As previously mentioned, this case study concentrates on the habitat compensation strategy as the unique aspect of this project.

Environment Canada, supported by the Wildlife Habitat Advisory Committee on Compensation, undertook a number of activities to compensate for habitat lost as a result of the expansion of the Vancouver International Airport:

1) Preparation of a strategy for compensating habitat losses.
   - The *Parallel Runway Wildlife Habitat Compensation Strategy* identified and described three main actions that would be taken to compensate habitat losses: land securement, enhancement, and private land stewardship.

2) Development of criteria for identifying lands for securement and enhancement programs.
   - Acquired lands were to have similar ecology to those lost on Sea Island, have good enhancement potential so that their carrying capacity could be increased to help absorb wildlife displaced from Sea Island, and be located in the lower Fraser River delta.
   - The order of preference for location of compensation lands was: Richmond; northwest Delta; south Delta/Boundary Bay area; elsewhere

within the lower Fraser River delta.

- Enhancement activities would increase habitat carrying capacity to make room for additional birds displaced from Sea Island, and cover all types of species affected, including waterfowl, shorebirds, passerines and raptors. Although management and enhancement activities would only be implemented on secured land to ensure the result contributes to wildlife conservation in perpetuity, they would not be restricted to lands acquired with airport compensation dollars. Preference for enhancement activities was, again, as geographically close to Sea Island as possible.
- An assessment was made of the enhancement potential of 28 protected sites in the Lower Mainland — including regional and municipal parks, provincial and federal wildlife areas, and some lands held by conservation groups. Based on this assessment, the Committee recommended priority sites to Environment Canada.

3) Exploration of conservation easements.
   - Conservation easements were explored as an alternative means to acquisition for securing lands. Easements are attached to the title deed of the property, and therefore protect the land for the long term.

4) Identification of possible enhancement projects.
   - Examples of possible enhancement projects are: wetland creation/restoration, creation of old field habitat, planting of trees and shrubs, removal of exotic and undesirable vegetation, installation of nest boxes and platforms, and water control structures to manage field drainage.

5) Identification of private stewardship projects that are beneficial to wildlife and also improve the capability of the land for agriculture.
   - Encouraged projects that help maintain soil-based agriculture such as winter cover crops (emphasizing the maintenance of viable farming, and securement of habitat); pasture rotation (rejuvenates soils and provides habitat for voles and raptors); and establishment of hedgerows (habitat for passerines).

6) Development of the *Evaluation Plan for the Parallel Runway Habitat Compensation Program*.
   - Documented a process for evaluating the merit, success and progress of the program. The process incorporates ecological, administrative and financial criteria. It is scientifically defensible because it relies on primary ecological criteria (i.e. criteria requiring empirical field research), in addition to secondary ecological criteria (i.e. criteria that are derivatives of primary ecological criteria or those having ecological relevance, but not requiring empirical field research).
   - In practice, evaluation of no net loss is accomplished primarily by evaluating the type and amount of habitat each project has provided. As implementation of the strategy proceeds, the Committee and CWS will make any modifications needed to keep the program on track. Evaluation will be a continuous and open process. Once it has been shown that each habitat type lost on Sea Island has been compensated for, and secured, elsewhere within the Fraser River delta ecosystem, the Committee will have achieved success in implementing the no net loss objective.

Results

In this case it was not possible for lost habitat to be compensated prior to development, but implementation of the compensation strategy coincided with the construction of the runway. Table 2.2 provides a summary of all the components of the strategy.

Land Transfer

Transport Canada transferred administrative control of two parcels of land to Environment Canada, totaling 171 ha and including:

- ***Robertson Farm***, approximately 31 ha

Table 2.2
COMPENSATION PROGRAM SUMMARY

Component	Habitat replaced as of July 1999	Value	Status
Land Transfers	171 ha		Transferred 1994-96
Acquisitions	148 ha	$6,000,000	Completed 1995
Stewardship and Enhancement Program	7 ha - hedgerow *(1.2 ha lost)*	$3,000,000	Ongoing
(179 ha to be compensated)	1 hectare - ditches, ponds and wetlands *(.7 hectare lost)*		
	350 ha - grassland *(116.8 ha lost)*		
	3 ha - wooded *(56 ha lost)*		
	3 ha - pond *(3.6 ha lost)*		

of prime agricultural land bordering the foreshore of Roberts Bank, primarily benefiting waterfowl, and to be managed as part of the Alaksen National Wildlife Area.

- ***Sea Island Conservation Area***, encompassing much of the land north of the new runway, approximately 140 ha of prime habitat for raptors and herons. Conservation of these species could be pursued without posing a risk to aviation safety.

Monetary Compensation

Based on the loss of 350 ha of wildlife habitat, and allowing for the 171 ha of land that will be transferred to Environment Canada, the Government of Canada agreed in 1992 to provide monetary compensation for the remaining area. Compensation funding was based on a ratio of 1:1 replacement of the 178 ha, at fair market value of non-commercial upland delta lands. As a result, Transport Canada transferred $9 million of funding to Environment Canada for enhancement and securement activities, as detailed below.

Land Securement

In 1995, Environment Canada entered into an agreement with the Greater Vancouver Regional District and the Province of British Columbia to become a partner in the Lower Mainland Nature Legacy Program. Environment Canada contributed $6 million towards the partnership's acquisition of three properties in Richmond totaling 148 ha, based on the criteria developed. The three-party agreement stipulates that the primary objective on the acquired properties is wildlife conservation, particularly for those species impacted by the airport expansion.

Habitat Enhancement

Environment Canada contributed $750,000 between 1995 and 1998 to improve the capacity of protected lands to support wildlife, such as those lands purchased through the Legacy Program or other lands held for conservation by government or non-government organizations. Enhancement activities commenced on selected sites in the Winter of 1996. Success of the habitat enhancements is being monitored by winter bird surveys at two of the enhancement sites

and photo-monitoring of vegetation growth at five of the enhancement sites.

Land Stewardship

In March 1995, following a competitive process judged by the Committee, Environment Canada awarded a $2.25 million grant to the Delta Farmland and Wildlife Trust to implement private land stewardship programs in the lower Fraser River delta. The income from this endowment, approximately $140,000 each year, will be used to run the stewardship program in perpetuity, for projects such as grass field set asides, hedgerow establishment and farmyard improvements. The Trust has established a Steering Committee composed of representatives of the Wildlife Habitat Advisory Committee, Environment Canada, the Corporation of Delta, the City of Richmond, and their own organization, to help direct the program.

The Trust developed a long-term wildlife monitoring and evaluation work plan, to ensure that the stewardship program optimizes wildlife use of replacement habitats. Results of monitoring and evaluation to date focus on comparative wildlife use of new and established habitats. These results guide stewardship activities, but are not conclusive regarding success of the program.

Reflections

This case study begs the question: Is "no net loss" an effective approach for ensuring sustainable development?

Despite the recognition of "no net loss" being a commendable and beneficial approach to mitigating losses, practitioners warn about the scientific and practical limitations of implementing such a principle. Trish Hayes of the Canadian Wildlife Service, Pacific and Yukon Region, emphasizes that compensation for habitat losses should always be a last resort in the mitigation process, after all attempts at avoidance and minimization of impacts have been made. No matter how skilled or experienced practitioners become at measuring and replacing habitat requirements for some species, ***direct losses of habitat will ultimately result in ecological impoverishment***. The Wildlife Habitat Advisory Committee on Compensation (1993) explains "No net loss is assessed at a very coarse resolution. Not all losses are accounted for. The potential ecological impacts of habitat loss on biodiversity at other scales of resolution — ranging from genes to landscapes — are unheeded, but may be critical." Hayes echoes these thoughts: "We have learned a lot through this compensation program about replacing habitat losses, but we must be realistic about what we are capable of achieving."

However, since other mitigation options were considered for this project before resorting to compensation of residual adverse impacts, no net loss of habitat capability was recognized as the best goal toward which to strive. The primary reason for this was the highly modified, intensely developed landscape of the Fraser River delta. Biologists were not challenged with replicating "pristine" natural habitat. Also, it was thought that the carrying capacity of alternative habitat could likely be increased since current carrying capacity was judged "sub-optimal." This would not be the case for pristine habitats.

Establishing the Wildlife Habitat Advisory Committee on Compensation was a novel approach at the time of the project. Hayes commented on the value of that Committee not only in advising Environment Canada on compensation, but in implementing the compensation strategy: "Establishing the Committee and working toward consensus meant that we got buy-in and advice from a wide range of groups. The consensus process was time consuming, but in the long run, the program was a lot better for it. The group took ownership of the program, and its success became a shared responsibility. It is definitely the approach to take in the future if we want to conserve habitat at the landscape level." Hayes emphasized the importance of gaining and maintaining the trust of stakeholders, citing consistency in government representation at the table and open sharing of information as two factors critical to this trust: "The process of deci-

sion-making has to be as open and transparent as possible."

Hayes commends the Committee members for their commitment to the program: "After seven years the same people still come together around a common goal — that's real commitment. In fact, the non-government groups have really taken responsibility to ensure implementation, and they spend the time and effort necessary to get the job done. They are willing to work to ensure that the program continues to be a success." She also values the Committee members for their role in promoting conservation and believes that: "They've become another set of eyes and ears on the ground — they help keep us abreast of local issues important to the community." Her work with the Committee members has helped expand a network that benefits habitat conservation in the delta: "I'm grateful for the opportunity to build alliances and bridges that go well beyond this program to other aspects of my work."

One of the greatest challenges of the compensation program was overcoming barriers to innovation. Establishment of a stewardship program in perpetuity requires innovative solutions and approaches that are good for wildlife and for the landowner. It took time and creativity to develop a workable approach and gain the necessary support for such a program from many agencies and individuals.

The experience of the Airport runway project has also illustrated the importance of having good baseline data — on all the species affected — before construction begins on a project. Although substantial efforts were made to compile data on habitat types and species before runway construction, biologists think that design and evaluation of habitat compensation projects suffered due to lack of data. In hindsight, they could have used "a couple of years" to collect wildlife and habitat data on the runway site. Lack of data has meant that, in the final analysis, biologists cannot definitively conclude whether they have maintained habitat capacity across the landscape, for bird species and populations that depend on that habitat.

Biologists involved in this project also urge others embarking on mitigation design to factor in the cost of evaluating the results of mitigation measures. Specifically, they recommend that a minimum of 10% of the total cost of mitigating impacts should be budgeted for evaluation. This level of resources is essential to determine if habitat compensation measures are working.

Although actual success on "no net loss" is difficult to measure, biologists at Environment Canada recognize that substantial progress has been made on replacing the habitat capability that was lost to the Airport runway expansion on Sea Island. However, they hasten to reiterate two important messages from this experience. First, Environment Canada's partners in the compensation strategy have been key to the success of the program thus far. In fact, habitat conservation in the Fraser River delta area continues to benefit from partnerships with landowners that were established for the runway project. Second, although pleased with the results of the *Compensation Strategy*, Environment Canada biologists emphasize the importance of applying the other mitigation options — avoidance and minimization of impacts — wherever possible, and reserving the compensation option as a last resort.

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3.0 A Practical Framework for Applying Wetland Mitigation in Canada*

— Robert O. Bailey

This chapter outlines the theory and application of mitigation, with an emphasis on practical considerations needed to address the conservation goal of no net loss of wetland functions for wetland development projects undertaken in Canada. Information is drawn mainly from the experiences of wetland practitioners in Canada and the United States. These experiences were gathered in a series of interviews and reported in background papers for a National Workshop on Wetland Mitigation and Compensation (Bailey 1998; Loftus and Mansell 1998). The National Workshop proceedings (Cox and Grose 1998) and published literature round out the principal sources of information used in developing the framework.

This framework outlines steps and procedures based on expertise and experiences gathered on project planning, implementation and evaluation. The information needs and decision-making process are described for each stage of the mitigation sequence. A number of challenges typically faced by Canadian practitioners are discussed, and options to overcome barriers and constraints are proposed. Methods of countering uncertainty in the design of mitigation projects, and in monitoring and evaluation of projects, are presented.

The proposed framework establishes an approach to wetland mitigation for use in a Canadian context. The framework is not a stringent recipe for success in wetland mitigation, but a guide to approaches that have worked in Canada and the United States. Mitigation projects may be expansive in scope and detail. This framework outlines information requirements generally and alerts practitioners to some of the options and potential pitfalls inherent in wetland mitigation projects. It is not meant to replace the requirements set out under various federal and provincial policies and legislation; rather, it can help guide actions taken in support of these requirements, and can also guide activities to be undertaken without a legislative requirement.

Implementing the Mitigation Sequence

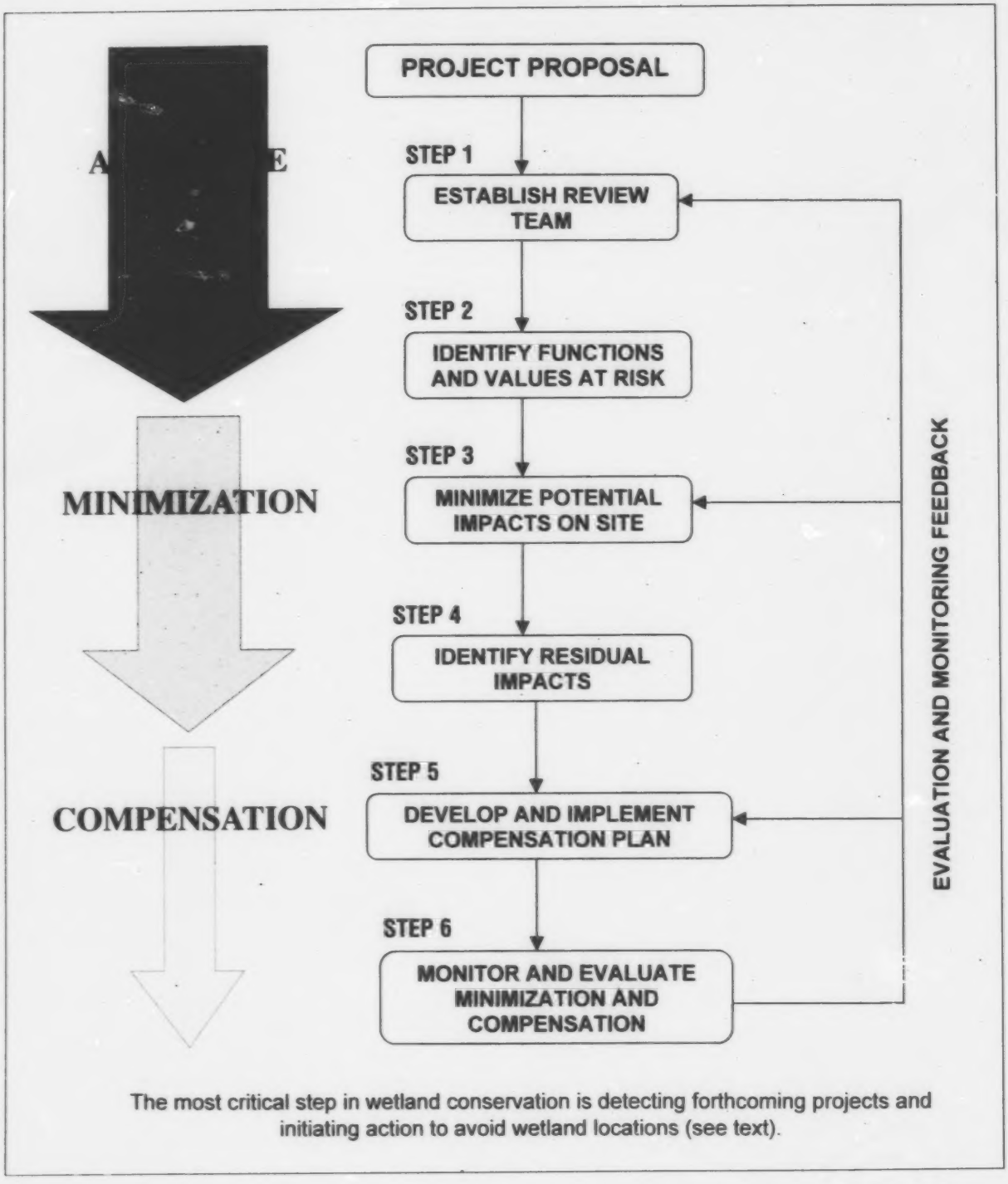
The purpose of this section is to give an overview of the decision-making and information gathering processes generally, and to provide a context for the types of information required to make decisions as the project unfolds. All steps may not apply in a given situation, depending upon the scope of the project and decisions relating to approval and timing of the work. Nevertheless, the following overview should give practitioners a framework to organize and assess the situation, to evaluate information needs and to foresee some of the challenges to meeting a no net loss objective. The steps and options to follow will also help practitioners and managers to determine a course of action, which would deal with the uncertainties inherent in mitigation and compensation initiatives.

The steps in this section outline the typical stages of the avoidance — minimization — compensation sequence (see Figure 3.1). Input during the early planning stages of a project is key to avoiding impacts and costly compensation measures. Initial scoping of the project proposal may indicate minimal potential for impacts on wetland functions, or point to options that would avoid the wetland entirely. The best chances to reduce damage to wetlands from development projects is to detect forthcoming proposals and alert proponents to the need for wetland considerations before construction is underway.

In the United States a permit is required under the *Clean Water Act* to allow construction in a wetland location. In Canada, environmental legislation at federal, provincial and territorial levels may apply, depending upon a wide range of factors such as the size of the wetland, the jurisdiction, the nature of potential impacts, if fish habitat is affected, and whether or not

* This chapter is adapted from a paper of the same title commissioned by the North American Wetlands Conservation Council (Canada).

Figure 3.1
STEPS IN THE MITIGATION PROCESS



The most critical step in wetland conservation is detecting forthcoming projects and initiating action to avoid wetland locations (see text).

federal policy implications, financing or other interests are involved. For a discussion of the policy and legislative framework for wetland conservation in Canada, the North American Wetlands Conservation Council (Canada) has published a comprehensive report (Lynch-Stewart *et al.* 1999). Most jurisdictions, including the federal government, are reluctant to enforce environmental policies and legislation. Often projects come forward for review and remedial action only because of public advocacy or legal action.

Wetland projects in Canada may receive political approval before any scientific or environmental information on the site becomes available. There is also a tendency to bypass the mitigation sequence and go straight to the question of compensation. In many cases developers prefer quick fixes and technological "add-ons" to resolve environmental problems. It may be easier for a company and government administrators to negotiate a financial package, including, for example, a fish hatchery to replace spawning and rearing habitat destroyed by the construction of a power dam, than to determine other mitigation alternatives. This approach minimizes delays in project approval and in the onset of construction activities, while maintaining the overall scope and size of the project.

Mitigation measures are often viewed as time-consuming and costly "additions" to a project, and can be especially disruptive to development planning when these measures enter the process after construction begins. This situation occurs frequently in Canada where public consultation is lacking in advance of the project or is deficient, and the concerned public alerts policy and regulatory agencies and the media late in the process. In addition, industry, and government departments at federal, provincial, territorial and municipal levels, may not be aware of constraints and barriers to development that are imposed by policies, regulations and other agreements. Finally, problems can also arise when engineering opinion is substituted for wetland ecosystem expertise, and fails to identify either the presence of wetlands on site, or their significant functions and values.

Government is often the proponent of projects in Canada, as well as being the environmental stewardship agency that reviews project assessments and grants approval. This dilemma can result in intense pressure on administrators and practitioners at provincial, territorial and federal levels for quick turnaround times on decisions and project approvals. Projects are seldom conceived far enough in advance to allow for the information gathering tasks and field studies required to adequately quantify functional losses in major wetland development projects.

Canadian development projects can enter the mitigation sequence at any stage, which may limit mitigation options or opportunities. These constraints often call for adaptive, innovative applications of wetland mitigation in an unpredictable social, political and economic climate.

Step One: Establish a consultative-participatory approach among the proponents, principal stakeholders and agencies as early in the project as possible.

Set up a multi-disciplinary, public-private sector review team or panel to oversee the project and the building of the database on the site. The panel will consider the information and options, and oversee the development, implementation, monitoring and evaluation of the mitigation plan. The panel will also direct and participate in public consultation and the distribution of information on the project.

The development of a Project Team or Advisory Panel for the project depends upon the scope of the proposal and the potential scale of impacts on the wetland environment. Projects on wetlands requiring an environmental assessment, or expected to significantly affect wetland capacity within a watershed or region, should be reviewed or managed by a team or panel comprised of the proponents and leading stakeholder agencies and organizations. The size of the team should be com-

mensurate with the scope of information, interests and decisions required. The team will require access to qualified expertise, the available experience in the field and the resources to fulfill information needs.

The project should be considered in light of the policy and regulatory frameworks available within the jurisdiction, and those that may apply nationally. Any appropriate triggers for the various acts and legislation with a bearing on the project need to be identified. A number of these instruments have prescribed procedures that must be followed.

Step Two: Identify and quantify the wetland functions and values at risk in the project to the extent possible.

The information needs outlined below would normally appear in the Environmental Impact Assessment for a project. The Terms of Reference for an assessment should outline information needs and specify the functional approach required to evaluate potential impacts to wetlands and to assist in the planning and design of mitigation or compensation options.

Examples of information needs:

- literature review and historical background to create an ecosystem, human use and resource profile for the site;
- field inventory/survey data of fauna and flora in the wetland, associated uplands and watershed;
- spatial/temporal dynamics and interrelationships among terrestrial and aquatic communities and resources;
- physiographic profile of the site, surrounding area and ecosystem characteristics;
- hydro-geological profile of the site;
- climate profile and potential influences;
- integration of the field and background information in a dynamic ecosystem profile for the wetland;
- identification of the affected functions; and,
- determination of actual and potential value of the functions/resources at risk.

Examples of information sources and tools include:

- scientific literature, government surveys and publications, and consultant reports;
- universities, fish and wildlife inventories, botanical surveys and profiles;
- inventories of rare, threatened and endangered species;
- federal and provincial wetland, land and soil classification systems;
- geological/hydrological surveys;
- water quality and flow monitoring data systems;
- information from utilities and other water regulators;
- the *Wetland Evaluation Guide* (Bond *et al.* 1992);
- *The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers* (Lynch-Stewart *et al.* 1996); and
- the North American Wetlands Conservation Council (Canada).

Step Three: With the information and expert interpretation in hand, work through the minimization process; develop and implement a plan to minimize potential impacts on site as appropriate.

Potential impacts normally include those resulting from the "footprint" or actual physical presence of the development structure, the impacts caused by construction or increased human use or presence in a location, and by the influences the development may cast upon the surrounding area and ecosystem. Examples of typical impacts are barriers imposed by new structures to the movements of fish and wildlife, losses of water quality downstream, and fundamental changes in the ecological character of a site brought about by project influences on the hydrologic regime.

This step examines the options for minimizing impacts identified above on the site. Modifications in the project design, rerouting roads or pipelines, or small-scale, low-tech measures such as sedimentation ponds, barriers or wildlife enhancement methods are examples of techniques which may be used to avoid or minimize functional losses on location. Every reason-

able effort must be taken before proceeding to the next step.

Step Four: Identify residual impacts.

The functional evaluation of the wetland is key to establishing the presence of residual impacts and the need for compensatory measures to achieve no net loss. This step is the decision point for proceeding with compensation. Where functional losses following efforts to minimize effects are determined to be "significant," a compensation plan must be developed and implemented to replace the lost or diminished functions.

The "significance" of functions and values is a decision based on the information gathered and the professional judgment of the ecologist, hydrologist, geologist or other professional engaged to evaluate wetland functions and values at risk. Large projects may require input from economists or sociologists to fully assess wetland values. Normally, an array of criteria is used to establish the significance of potential impacts. For example, criteria with a bearing on significance may include the overall role the wetland plays in groundwater recharge for the region. The consequences of impairing or removing this recharge function may be manifested in lower water tables. This could result in inadequate water supplies for agricultural purposes during midsummer and a need to irrigate crops, or could cause water shortages in residential communities.

The significance of impacts on fauna and flora are usually determined by considering the relative abundance of species and communities, coupled with human use of renewable resources produced in wetlands. For example, the presence of a rare, threatened or endangered species has greater implications for development plans on a proposed location. Unique floral communities within a region are significant elements in an assessment. Seasonal use of coastal wetlands by spawning fish, which support recreational and commercial fisheries, or use of a wetland by a large proportion of a migratory bird population conveys added significance. Comparative rarity of the wetland type itself on a geographic basis is associated with various degrees of significance.

A critical point in determining the requirements for compensation and assessing the level of significance for a range of impacts is to ensure that ***only*** qualified experts within the respective fields make the evaluations required for the decision-making process. This does not preclude input from local interests; in fact, the importance of wetland benefits to local interests must be taken into account. However, this information must be gathered and evaluated by those professionally qualified to do so.

Step Five: Select the appropriate compensation option(s); develop and implement the Compensation Plan.

Residual impacts on wetland functions and values must be compensated to achieve no net loss of wetland functions and values. Once the nature of functional loss and/or impairment has been determined, the review team or panel should consider developing a Compensation Plan.

Compensation in a no net loss context requires clear goals and objectives, which should be developed by the project team at the outset. The overall goal of compensation should relate to the restoration and maintenance of the chemical, physical and biological integrity of the wetland ecosystem, which supports the functions and values identified. Specific objectives under the goal should be determined for each of the significant functions and values impacted or lost in the project.

In Canada, several options may be considered for re-instating or replacing the lost wetland functions. Often a project team may achieve unique solutions to resolving complex social, economic and environmental issues related to the development of a wetland area, and it is difficult to describe "textbook" solutions, which would be applicable in all situations across the country. On the other hand, the functional approach to evaluating wetland impacts, and the physical and biological nature of wetland locations, are conducive

to establishing consistent goals and practical options for achieving no net loss. Compensation options are reviewed in the next section.

Step Six: Monitor and evaluate the outcome of mitigation projects.

Monitoring and evaluation of objectives under mitigation plans is critical to determine whether or not the goal of no net loss of the various wetland functions and values has been effectively achieved. The mitigation process is incomplete without a thorough and well-planned strategy for monitoring and evaluating the outcome of plans and projects.

Traditionally, monitoring has not played a major role in Canadian projects, although it is becoming a more prominent consideration as awareness of long-term environmental issues expands. This process is also vital to building Canadian experiences and technologies required to harmonize the interface between an expanding economy and benefits provided by a healthy environment.

Planning, Implementing and Evaluating Wetland Mitigation Measures

Considerations for Minimization Measures

Mitigation is vital to contain cumulative losses of wetland functions on an ongoing basis over a broad geographic area. Several resource development industries have adopted mitigation standards and measures, which are appropriate to the specific environments encountered during the course of field operations, and are incorporated as best management practices by the companies. This level of mitigation technology is critical to achieve no net loss of wetland functions.

It is important for practitioners and decision-makers to develop specific mitigation applications, which are appropriate to the types of wetland environments encountered on the properties they manage, and for the kinds of smaller-scale impacts likely to occur. It is also critical that land managers monitor and evaluate the outcome of mitigation practices, to build the base of information on effective mitigation technologies in Canada. It is only through the long-term experience and evaluation of field techniques that a practical knowledge base of workable measures can be acquired.

In a broader context, on-site minimization activities are likely to occur in most projects whether or not compensation of residual impacts is required. Specific mitigation measures undertaken will depend upon a wide array of circumstances, which cannot be adequately treated here.

The focus of this section deals with compensation planning, implementation and evaluation. However, some of the material has a bearing on issues and decisions related to other aspects of mitigation.

Considerations for Compensation Options

Practitioners should be aware that achieving the goal of "no net loss" of wetland function through compensation measures presents a number of practical challenges and constraints. The foremost challenge is dealing with the uncertainty inherent in determining which functions are to be replaced, and what options and technologies are available to meet this task. Qualitative and quantitative assessments of potentially important wetland functions, such as flood control, water quality improvement, groundwater recharge and habitat functions are difficult to obtain with precision on undisturbed wetlands, much less after construction has started. Seldom are adequate lead time or sufficient resources committed to a project to develop reliable assessments of functions and their values, or to ensure that these can be fully compensated in another location.

A pragmatic view of the no net loss principle is the working reality of successful wetland conservation in most of the best known cases involving compensation projects in Canada. Kusler (1997) suggests that it is easy to be misled by following "a highly simplified standard of no net loss of func-

tion." In fact, it is exceedingly difficult to define and recreate wetland functions in quantitative terms, using the current science and technology available on wetland ecology. Nevertheless, no net loss of function is a useful conceptual goal to guide wetland policy, and to encourage sustainable development through ecosystem compensation for wetland impacts.

Scientific expertise on wetlands and extensive field experience are critical resources for reducing uncertainty in the design and implementation of mitigation and compensation options for wetlands. A lack of scientific expertise is a prominent feature in the failure of compensation projects in the United States (Hammer *et al.* 1994), and is often implicated in the poor quality of work performed in Canada. Experienced biologists can bring the art and science of wetland conservation together in the design, construction and operation of wetland projects. The critical role of field experience becomes vital to success in the compensation decision-making process, when time and resources are not available for research. Expertise is needed to recognize compensation opportunities and recommend appropriate options, to overcome constraints, and to provide the practical solutions needed to meet conceptual policy goals in a complex landscape.

The following six compensation options, more fully described below, have both pros and cons associated with them:

(1) Creation of replacement wetlands;
(2) Wetland restoration;
(3) Wetland enhancement;
(4) Exchange of wetland areas/ wetland securement;
(5) Compensation banking; and
(6) Other harmonized solutions.

(1) Creation of Replacement Wetlands

Wetlands may be created to compensate for functions and/or area lost or impaired through development. Creation refers to the construction of a wetland where none previously existed. The approach, information needs, issues, considerations and decisions required to create compensatory wetlands are fundamental to all of the compensation options covered in this section. For this reason, much of the background required to choose, implement and evaluate compensation options will be presented in this section and expanded upon in the next section.

Creation can occur on-site, where an impacted wetland is extended to compensate for the area damaged, or it may be undertaken off-site. In general, on-site compensation is preferred, as the hydrology and physical attributes surrounding an established wetland may be more conducive to the development of a successful wetland creation project.

Wetland creation in areas away from the development site increases the uncertainty associated with achieving the goal of no net loss of functions and values. On-site compensation is most likely to address losses of functions contributed by the impacted wetland to the surrounding area, watershed or ecosystem (Kruczynski 1988; Lowry 1988; Hammer *et al.* 1994).

The science of wetland creation is not well developed. Experiences in Canada and the United States show that some classes of wetland are much easier to create than others. Techniques for creating marshes with open water communities of emergent vegetation, swamps, wet meadows and wetland-shrub communities are better known than options for developing forested wetlands, or fen and bog communities. In general, early succession wetland types with high primary productivity are easier, and require much less time to create than the more ecologically advanced types. Productive wetland classes tend to support a broader diversity of flora and fauna, and are sometimes perceived by the public to be more "successful" as compensation.

Examples of potential locations for compensation projects conducive to the establishment of early stage wetlands can often be found in areas where shallow water has been inadvertently impounded. Roadways and poorly-drained construction sites close to the proposed development project can give an indication of the type of early stage wetland which may result from flooding a

comparable location over a given time period. However, early stage wetlands may not fulfill the range of wetland functions lost at the development site.

Wetland functions should be well defined at the outset to ensure that all functions are considered and compensated as appropriate. Often compensation wetlands are not the same type as those lost in a watershed because of the difficulties in creating forested swamps, bogs and fens. There is a tendency to favour early succession wetlands as compensation, because the public can relate more easily to highly visible functions and values such as wildlife habitat. In some cases, it may not be practical or possible to create the same type of wetland in a compensation project. This may be justified where the functional values of the wetland to the ecosystem are fully compensated in the design, and if a significant ecological bottleneck is removed for a rare, threatened or endangered species, or another, relatively rare and valuable function is enhanced.

(2) Wetland Restoration

Wetland restoration involves replacing wetland functions and values lost by restoring a former wetland on the project site or in the vicinity. The foremost consideration for meeting compensation needs off-site is to locate a former wetland nearby or in the same river reach or watershed, that has been drained and could be restored. Wetland restoration is the most effective method of compensating lost values as it is much easier to rehabilitate a drained wetland than to create a new one. Most wetland development occurs in wetland-supported ecosystems in southern Canada, where there is a history of significant wetland losses. Areas that have been previously drained for urban development or agriculture may be appropriate for restoration.

Wetland restoration is much more predictable than wetland creation as an option to replace functions and values, because a wetland previously existed on the site. If the soils and general configuration of the wetland are intact, the restoration may involve a simple addition of water. Nevertheless, it is still important to assess the functions lost on the impacted wetland and to determine if conditions on the restoration site are conducive to replacing them. In general, the closer the restoration site is to the project, and the more similar it is in hydrology, soil profile and other characteristics, the more likely it is that the compensation project will achieve no net loss objectives.

(3) Wetland Enhancement

Enhancement involves the use of techniques to improve specific functions and values of a location, as compensation for the loss or degradation of these functions in an impacted wetland. Enhancement may occur at the development site or in a different location. In the past, enhancement has involved measures to increase the productivity or attractiveness of wetlands for wildlife, as compensation for habitat or wetlands lost in another area.

In Canada and the United States, the loss of the wildlife habitat function has traditionally been a focal point for wetland mitigation, and particularly for compensation. Until recently, functions related to groundwater recharge, flood control and water quality have been overlooked.

Practitioners should exercise caution and thoroughness in their assessment of functional losses in wetlands, to ensure all functions have been considered before proceeding with enhancement as the compensation option. Functions such as groundwater recharge, flood abatement and water quality improvement are much more difficult to assess. Many valuable techniques are available for enhancing wetland functions, but practitioners should be sure that certain functions are not enhanced to the detriment of others, and that the more difficult functions to assess and replace are considered.

The complex issue of ecological trade-offs sometimes arises in enhancement projects. For example, the flooding of a meadow to expand wetland area along a stream may result in the loss of habitat for a rare plant but improve waterfowl production. In some cases, trade-offs may convey overall benefits to wetland functions and the

watershed or ecosystem by eliminating a class of limiting factors, but not in others. A broad knowledge of the ecosystem, resources and dynamic relationships is required to make these decisions.

Enhancement is often targeted at the rejuvenation of wetland ecosystems by setting back ecological succession to an earlier stage. This process may favour, or confer competitive advantages to different communities of plants and animals. Fundamental changes in the nature of a wetland may be precipitated by modification of the water regime. Enhancement proposals should be carefully assessed, to ensure that the proposed actions do not reduce habitat values for non-target species or result in other, unforeseen changes in wetland functions and values. Often, enhancement options are available for fish and wildlife resources, which are not likely to produce major effects on the wetland or ecosystem.

(4) Exchange of Wetland Areas/ Wetland Securement

Habitat exchange has been used in Canada and elsewhere as compensation for wetland losses. However, exchange usually involves the handing-over of a wetland or non-wetland area as compensation for developing another site. Exchange may result in the protection of a larger wetland than the area lost to development, but overall there is a net loss of wetland functions and/or area in the process. It is also difficult to guarantee the protection of exchange wetlands in perpetuity. Habitat exchange is generally not considered to be adequate compensation for wetland losses. In most cases, exchange amounts to little more than bartering or purchasing the right to destroy a wetland.

(5) Compensation Banking

Compensation or mitigation banking has become prominent in the United States as a method of compensating wetland losses (Loftus and Mansell 1997). Development companies may create or restore wetlands for receipt of a certain number of credits depending upon size and other characteristics of the site. Wetlands impacted or destroyed by the company in other locations may be evaluated in terms of credits and compensated by withdrawing the same number of credits from the compensation bank. In theory, this practice could result in no net loss of wetland functions.

The principal advantage of a compensation banking scheme is the flexibility given to proponents and to wetland conservation interests. Rather than require a proponent to compensate the loss of wetland functions by constructing a wetland of marginal value in an inappropriate location such as a parking lot or shopping mall, the proponent can purchase credits from the compensation bank. This allows the flexibility to create worthwhile projects in more appropriate surroundings.

The banking concept may be used by conservationists to focus resources on reducing limiting factors to rare, threatened or endangered species, or as an approach to conserving unique, threatened communities within an ecosystem. The flexibility of compensation banking encourages innovative options such as building corridors between fragmented habitats or assembling habitat areas of a critical size for species at risk.

Drawbacks to the banking concept relate to how money is used to buy credits and to the difficulties in defining and meeting no net loss of wetlands under the scheme. Some practitioners feel that the need to avoid developments in wetlands, and to properly assess impacts and options, may be diminished by the banking concept. Too often this concept of banking leads the proponent to jump past avoidance, overlook minimization and offer cash as compensation. However, it is possible that a carefully conceived and ethically operated compensation bank might contribute some flexibility to reach higher conservation goals and achieve no net loss under challenging circumstances.

(6) Other Harmonized Solutions

The participatory-consultative approach outlined earlier is intended to result in a win-win situation for developers, conservationists and other stakeholders in wetland development projects. Building this

approach, at whatever scale, should be the first priority of project managers. Although resources are required from the proponent to build the database on a site, to consider a range of tools, options and methods of applying them to achieve no net loss, there is no discussion of compensation at the onset of the process. The review team or panel strives for a harmonized solution considering all interests, and specifically avoids negotiating ecological trade-offs. The method has been used in Canada by governments to compensate wetland losses in major development projects involving a broad range of public and private sector interests, such as the parallel runway project at the Vancouver International Airport (see Case Study 2.7 herein).

Wetland Creation and Restoration Options: Information Needs and Considerations for Planning and Implementation

Wetland creation and restoration is an art enhanced through experience, and a science based on a body of accumulated knowledge. Both must be applied to develop successful compensation outcomes. Compensation projects should always be based on the best knowledge and experience available. It is incumbent upon all participants to ensure that expert capability is used on the project.

The following framework outlines information needs and considerations for planning wetland creation or restoration as compensation for the loss of wetland functions. The information needs are based on experiences in Canada and the United States (Kruczynski 1988; Lowry 1988; Hammer *et al.* 1994; Bond *et al.* 1992). It is seldom possible to completely fulfill the information gaps and conditions needed to guarantee 100% success of a wetland compensation undertaking. However, assembling a core set of baseline data and using well-qualified expert interpretation and experience can significantly enhance the chances of meeting no net loss objectives.

Hydrogeologic Setting

The ground and surface water relationships (recharge-discharge) on the impacted area should be described on a seasonal basis. The significance of these functional relationships to the surrounding area, groundwater supply, watershed or ecosystem dynamics should be established to determine which functions are the most important in the new project. The wetland creation or restoration site should be closely examined and assessed during the preconstruction phase to see if the relationships and functions described for the wetland lost or impacted can be reproduced on the new site. This task is easier to achieve within the same hydrogeologic unit or reach of a riverine system. A thorough understanding of what is being lost or altered must be established, and the capability of a new area to give rise to the intended hydrologic conditions confirmed.

Needs and Considerations:

- test borings to understand subsurface profile as it relates to hydrogeologic properties;
- determine water table characteristics;
- an estimated water budget should be constructed under the new conditions;
- the feasibility of constructing on a new site should include logistic considerations such as the need for diversions, drawdowns, machinery operation, the types of machinery to be used and soil sources etc.;
- in situations where more restrictive hydraulic conditions are proposed there may be a need to model the water budget and build in provisions for surface water level controls to correct for inaccurate predictions; and,
- the re-creation of hydraulic conditions required in wetland creation or restoration projects may be a challenge for construction crews and engineers. Success often depends upon the ability of operators to understand the plans and to use their equipment to meet specifications.

Soil Profiles

The organic horizon is the most difficult aspect of a wetland to replace. The soil profile is the foundation of a wetland. It influences ground and surface water interactions, water quality maintenance, flood storage capacity, and factors such as

shoreline erosion functions more than any other wetland component. The soil or substrate at the new location must be suitable to support vegetation regeneration and the wetland functions to be replaced.

The type of soil used depends upon the conditions encountered at the wetland creation site. Low-lying areas are naturally conducive to wetland formation, especially where the water table is close to the surface. On occasion, wetlands may be located well above the water table. Creation of an impervious or semi-pervious layer below a saturated, organic layer may be needed. Many wetlands in the prairie region have a "hard-pan" impervious base, which is difficult to replace if breached by cultivation.

Dikes and other water level control structures may be made of less pervious materials than the floor of a wetland. Special consideration must be given to embankments exposed to current, storm events and wave action. Most of the decisions about the types of soil to use in the foundation, organic layer and structural components depend upon the uses of the created wetlands and the availability and cost of materials.

Wildlife and domestic animals can have a significant impact on the success of creation, restoration and enhancement projects. Cattle with free access to wetlands, shorelines, streams and ditches can quickly destroy these areas by impacting the soil, degrading the vegetative cover and enhancing the loss of the organic layer through run-off erosion. This causes the exposed impervious layer to dry, harden and no longer support many wetland functions. Salinity of alkali soils is often increased with compaction, prohibiting the growth of all but the most salt tolerant species. Erosion control and damage by burrowing animals such as muskrats should be considered in plans for maintaining structures. Sometimes loose, sandy soil can be used in the upper portion of a structure to discourage burrowing animals.

In a restoration project, the original wetland soil profile may be intact, which greatly helps the task of reestablishing several functions. Wherever feasible, the upper layer of soil from impacted or destroyed wetlands should be removed and used at wetland creation sites.

Other considerations:

- performance of the soil type, nutrient content and other chemical parameters should be considered, as well as how any projected changes in the physical/chemical environment may influence the delivery of targeted functions, under the conditions to be created;
- thickness of the soils required in the creation project to achieve functional objectives; and,
- practical on-site considerations for developing the soil profile that will meet the required specifications for functions on the creation or restoration project, such as drawdown to deposit the soil, ability to grade soils to elevation specifications, control of sedimentation and erosion while vegetation is being reestablished, elimination of wildlife depredation on planted/seeded sites and minimizing human intrusion and disturbances.

Biological Characteristics

Biological characteristics of a site should be documented to assess the functions of a wetland as fish and wildlife habitat, in supporting unique species or floristic communities, and to determine the role biological characteristics play in contributing to other functions and values.

Biological characteristics are important in supporting such functions as water quality, flood control, recreation and resource based tourism. A thorough understanding of biological factors is critical to replacing productivity and life-support functions, which depend upon nutrient cycling and the unique nature of trophic dynamics within a given wetland ecosystem. Identification of limiting factors in the wetland to be replaced could also result in a net gain for biological functions in the newly created or restored wetland, where this is desirable.

Information requirements needed to describe biological functions in wetlands

were outlined earlier. A key element in the successful planning of compensation projects is the ability to "organize the pieces of the ecosystem puzzle" by tying together the physical and biological components of a location. Information integration in an ecosystem concept is key to determining which functions are significant or most valuable, and how they may be replaced at the new location. An array of options are available for replacing or enhancing biological components and these will depend upon the suitability of the combined characteristics of the compensation wetland.

Options for replacing fish and wildlife functions include restocking, reintroduction or using several methods to promote natural propagation or occupancy on the site. A wide range of enhancement techniques such as the building of nesting structures, spawning habitat, planting food sources and cover are available to encourage use by fish and wildlife. A considerable amount of research and practical experience is available on specific species and community requirements, food preferences and cover types, ratios for the dispersion of aquatic and terrestrial vegetation, and interrelationships between wetland and upland components of wildlife habitats. It is beyond the scope of this paper to review the extensive information available for re-introducing or enhancing fish or wildlife abundance on compensation projects.

Vegetation

Success of propagation or enhancement techniques and efforts to recreate biological components in a new location will depend upon the overall success achieved in replacing the habitat functions on a creation or restoration project, and the removal of any limiting factors to desired species or communities in the project design. The reestablishment of the vegetation on a compensation site is a fundamental precursor to the rebuilding of fish and wildlife communities in the project area.

Re-vegetation of a creation or restoration project is a basic consideration, as a robust floristic community provides and sustains many physical functions such as flood attenuation, pollution abatement and other water supply and quality functions, as well as serving as a foundation for re-instating biological communities. Once a suitable soil profile has been prepared, and the appropriate water regime is in place, most creation sites have to be seeded or planted to control erosion on banks in the short-term and to promote the rapid development of a desirable plant community.

The type, distribution and density of vegetation used in a compensation wetland depends upon the principal functions to be replaced. For example, flood control and pollution abatement may require broader coverage by dense stands of emergent vegetation such as cattail. The dense vegetation stands slows the velocity of flood waters, increases detention time in the wetland, and permits the uptake of nutrients and other pollutants such as heavy metals by the plants.

Wildlife habitat functions tend to be most efficient using a ratio of about 50:50 open water to emergent vegetation. The open water promotes the growth of submerged aquatic plants and invertebrates used as food by wildlife, and permits easy access to cover. Wildlife habitat often requires different species of aquatic vegetation and substrate in a wetland, from those used for other functions. For example, bullrush species growing on a firm, organic soil base may support a much more biologically diverse community than cattails growing on a soft mud bottom. Dispersed stands of bullrush tend to provide much better food, cover and breeding habitat for birds, fish, mammals, reptiles, amphibians and invertebrate species.

Natural colonization of the site by vegetation from the surrounding area is often the most desirable option, as it entails less cost and risk than bringing in plant materials from commercial sources. Developing alternative types of soil profiles, vegetation and aquatic communities can be more difficult than creating the ubiquitous cattail community over a mud substrate, which tends to be the industry norm. Colonization can be achieved by transferring plants, soil or soil cores from the

impacted location, or from surrounding wetlands. Practitioners should be aware that a wide range of specific information must be considered, such as species tolerances and geographic variation for selecting and establishing floral communities appropriate for the region and the project functions. It is also noteworthy that timing of seeding and transplanting operations can have a significant bearing upon the outcome.

Compensation Ratios, Timing and Slopes

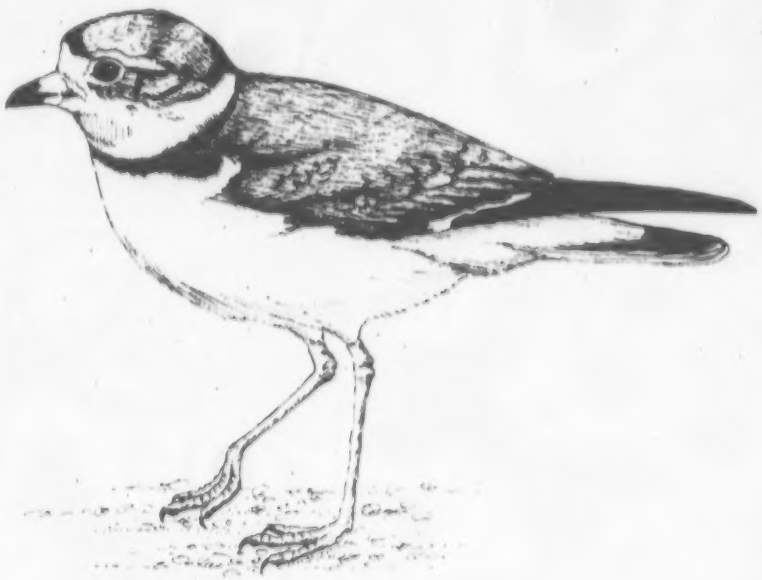
Compensation ratios are established to counter the uncertainty of meeting functional losses in newly created, restored and enhanced wetlands. Ratios are also considered on a case by case basis for other compensation options.

Compensation wetlands are often twice as large or more than the wetland impacted or destroyed. Higher replacement to lost wetland ratios (usually based on area) are established in compensation plans to offset functional losses caused by inefficiencies in the compensation project. Scientific knowledge related to the reestablishment of wetland functions in creation, restoration or enhancement projects is incomplete. Scientific information is seldom directly applicable to the project at hand or for all the functions at stake. Many uncontrollable sources of variation exist in the natural environment, making it difficult to replace a full suite of lost wetland functions in one area, with the exact same suite of functions and values on a similarly sized compensation wetland. Ratios based on wetland area are used to offset the uncertainty encountered in replacing functions on a compensation site.

The size of the compensation ratios used depends upon the value (and complexity) of the impacted wetland, timing of the compensation project in relation to construction of the development project, and the nature of the functions that require replacement. Kruczynski (1988) provides an overview of theory and methods for establishing compensation ratios used in projects in the United States. In Canada, several factors can influence the ratios used, including public perceptions and political pressures.

Ratios for compensation projects under a no net loss policy should be guided by what is required to fully replace the functions and values impacted or destroyed. Where field measurements are not available to quantify functions and wetland construction capabilities are minimal, larger ratios of compensation area to impacted wetlands may be necessary to ensure no net loss of functions is achieved.

In theory, information should be gathered on larger projects well in advance of construction. Sufficient lead time and resources for field studies allows a more thorough assessment and quantification of the functions to be replaced. Properly funded projects, spanning two to three years or more in advance, directed by qualified scientific experts and reputable consulting firms, could save proponents money by reducing the uncertainty associated with replacing lost functions. Under these circumstances, a ratio closer to 1:1



may be adequate to achieve the no net loss goal on the compensation project. For typical, smaller wetland projects on site or in the same reach, using the same soil profile and vegetation community, the work may be conducted concurrently with the development, at close to a 1:1 ratio.

Complex projects with several unknown functions require planning and implementation of the compensation project well before the onset of construction activities. In situations where compensation is undertaken ahead of site development, the proponent has an opportunity to demonstrate the success of achieving the policy goal on the compensation project before development is permitted. This approach is being used to enhance the success of compensation projects in the United States and may be applicable to developments proposed on federal lands in Canada. In these circumstances the onus is on the proponent to demonstrate the success of the compensation measures in advance. Compensation ratios recommended for projects include: wetland restoration 1.5:1; creation 2:1; enhancement 3:1 and others on a case by case basis (Kruczynski 1988).

Wetland development projects in Canada often involve large, complex wetland systems and associated uplands. Unfortunately, compensation is planned and implemented for many sites with little lead time for gathering field data, quantifying functions at risk and determining the potential available on the compensation area to meet requirements of no net loss. Under these circumstances, much higher ratios of compensation to lost wetland area may be justified to address the no net loss directive.

The most critical aspect with respect to the timing of compensation projects in Canada, is whether or not the project is planned far enough in advance to allow vital field information to be gathered on the development project and compensation site. Lead time for research and information gathering is highly relevant to the success of Canadian compensation projects. Far too many Canadian projects rely on inadequate, outdated information. Current data, gathered on site, under the direction of fully qualified scientific experts, is fundamental to guiding the planning and implementation of compensation measures.

Other timing considerations include: determining the optimum season and weather conditions for re-vegetation efforts and any fish or wildlife re-introductions required; timing construction to avoid disadvantageous weather or flooding events, and to minimize disruption to seasonally-dependent life-cycle events for fish and wildlife such as nesting, migration or spawning.

The slopes of constructed wetlands, shoreline banks, streams, ditches or channels should be gentle as a rule to ensure rapid re-vegetation, to create a broader flooded area for wetlands and littoral zones, and to avoid erosion. Vertical to horizontal slopes used on most projects range from 1:5 to 1:15. As a general rule, gentle slopes ease the transition between terrestrial and aquatic environments, are more rapidly stabilized by early plant colonization, and offer more favourable and efficient conditions for reestablishing wetland functions.

The shape of compensation wetlands is partly determined by the functions they need to replace. There is a tendency to "over-engineer" wetlands created for water quality, flood control and other functions, resulting in square or rectangular constructed wetlands that are not functionally nor esthetically integrated in their surroundings. Compensation wetlands should follow the natural contours and configuration of their environment to fulfill a broader profile of functions in an esthetically pleasing manner.

Characteristics of the borders surrounding compensation wetlands are key to efficiency in fulfilling several functions. The nature and depths of wetland borders vary greatly, depending upon specific functions, size, position of the wetland in the watershed and other factors (DeLaney 1995). Guidance to equipment operators is required in the field to avoid steeply cut slopes on ditches and the leveling of spoil piles without damage to natural vegetation. The type of construction equipment used

by a contractor can determine the ability of field crews to meet project specifications. Equipment required for more critical tasks should be specified in the contract and procedures reviewed with the operators well before the work to minimize misunderstandings and collateral damage to wetland locations.

Ecological Trade-Offs

Ecological trade-offs may occur as planned or unplanned consequences of wetland degradation, loss and/or compensation decisions. For example, an enhancement project may be undertaken to improve the wildlife habitat function on a nearby marsh as compensation for draining a wetland. The capacity of the marsh may increase for waterfowl production, although a dike created for the enhancement project precludes access to the area by spawning fish from an adjacent lake or river, resulting in loss of recreational and commercial fishing opportunities.

Ecological trade-offs or costs of compensation that alter fundamental characteristics of terrestrial and aquatic environments are an ongoing concern in projects. The nature of potential costs and benefits, and how these relate to the significant functional values to be compensated under no net loss should be thoroughly assessed in the compensation planning process.

Experience shows that trade-offs among species of high commercial or recreational value with those of lesser interest are common in Canadian approaches to mitigation. Ecological imbalances can result from a narrow focus on socio-economically important resources in compensation planning. These imbalances are induced by a traditional focus of environmental field studies and impact assessments on highly visible components of ecosystems, and public advocacy for retaining the more "valuable" components of fish and wildlife in development projects.

Institutional barriers created by government mandates, acts, treaties and regulations limit the interests of environmental and resource management agencies to certain species or groups, and severely constrain the role individual agencies can play in the management of ecosystems and impacts. These constraints direct agencies to limit their involvement to species or habitats "of interest" under their mandates and encourage trade-offs, often to the detriment of non-commercial species, biodiversity or life-support functions in wetlands and aquatic environments. For example, the focus of Fisheries and Oceans Canada on "fisheries," rather than fish and the aquatic ecosystems that support them, has resulted in trade-offs enhancing commercial fisheries at the expense of non-commercial species under the no net loss goal of the federal *Policy for the Management of Fish Habitat.*

Trade-offs can also arise inadvertently among other wetland functions such as flood control, groundwater recharge, water quality and others. These trade-offs occur because it is difficult to assess the scope and value of the less visible functions in a wetland. Less visible functions may be among the most valuable to the watershed, ecosystem and the broadest human constituency. There has been a tendency in Canada to minimize evaluation efforts directed at collecting field data, particularly for the least visible, functional components of wetlands. Inadvertent trade-offs of one function for another result when information and knowledge sources are insufficient to detect and describe the less apparent wetland functions.

Several methods of habitat evaluation have been attempted in the United States to provide an objective assessment of the amounts and values of habitats lost and gained through development and "compensatory mitigation." Evaluation tools are sometimes used to assist in decisions concerning ecological trade-offs. These indices are based on parameters such as "habitat suitability" for certain species. An ecosystem approach and thorough knowledge of past, present and future potential of the site in its unaltered form is necessary to use habitat evaluation tools with confidence. There is great latitude for the misuse and misinterpretation of tools for measuring the value or significance of wetland functions and resources, particularly in the hands of unqualified people.

Unfortunately it is common for consultants to misuse assessment tools, to downplay functions and values in the hope of gaining project approval, circumventing regulations or containing costs for the proponent. Consulting firms often try to "get by" or "muddle through" environmental assessments using evaluation tools with little or poor data on fish, wildlife and ecological relationships given by an engineering group. Although many consulting firms are pushed into this situation by government and private sector focus on price in competitive bidding processes, inadequate products can be challenged and may entail several follow-up costs to the proponents.

Proponents should seek the best ecological expertise and information available to make informed decisions. In this way, proponents and regulating agencies can be advised of the real costs and plan compensation accordingly. A straightforward approach involving community stakeholders, qualified experts within the appropriate field and the responsible management agencies, minimizes the threat of future legal action or adverse public reaction to the venture. Public protests and legal challenges in Canada can have far-reaching consequences on a project and the proponents. Projects have been successfully terminated by community action and proponents have faced bankruptcy in the process.

Monitoring, Evaluation and Adaptive Management

A no net loss policy opens the door to considering mitigation measures to prevent the loss of wetland functions and values in the face of development. Although some wetlands should never be developed, and not all functions can be compensated in every situation, no net loss policy offers an opportunity to harmonize economic development with environmental stewardship.

Monitoring, evaluation and the application of adaptive management principles are vital components of the accountability and learning processes relating to mitigation. Monitoring is needed to ensure that proponents meet their obligations under development agreements and to evaluate success in meeting no net loss objectives. Monitoring should be transparent and accessible to the public.

The science supporting wetland compensation in Canada is not well developed and project implementation contains a high degree of uncertainty and inherent risk. The science surrounding the replacement of wetland functions is critical to wetland compensation potential. Practical solutions to working in and near wetland environments will become more important to wetland practitioners, developers, regulatory agencies, stakeholders and the public as development expands in remaining wetland-supported ecosystems.

Building the knowledge needed to replace wetland functions through scientific research and practical experience is the key to the successful design and implementation of compensation projects in the future. Research on wetland ecosystems is a long-term undertaking, which is now unlikely to provide many of the answers needed in the short term to achieve no net loss of functions through wetland mitigation and compensation. Research should be guided and assisted by practical experiences in implementing mitigation and compensation in the field.

Monitoring and the evaluation of mitigation measures and projects offers an opportunity to build upon and accelerate the knowledge gained through research.

Adaptive Resource Management

Learning must become a foremost component of wetland mitigation implementation, as sustainable development of wetlands cannot be attained with the limited knowledge currently available for replacing wetland functions in Canada. Adaptive resource management (ARM) is a management and learning process developed to meet the challenges of managing resources in the face of uncertainty, with a focus on monitoring and assessing the outcomes of decisions to reduce uncertainty in the future. ARM may also be defined as a process of learning about system responses through the experience of management (Walters and Hilborn 1978).

Adaptive resource management differs significantly from haphazard learning and decision-making through trial and error, although ARM may be confused with the latter. ARM is a sequential, ordered process, which targets learning *and* management performance as two distinct sets of products resulting from program implementation. Monitoring information is used to verify predictions from competing response models and the knowledge gained through experience is incorporated in the process to improve future decisions.

The strength of ARM emerges in conservation decision-making where four principal sources of uncertainty, namely — environment, incomplete management control, sampling error and structural uncertainty — pose risks and potential limitations to management performance (Continental Evaluation Team 1998).

Environmental uncertainty stems from uncontrollable environmental factors, which may curtail management objectives. For example, unanticipated changes in the moisture regime caused by climate change may limit success of otherwise well-planned compensation measures. Incomplete management control refers to the inability to consistently predict the outcome of management options in a given situation. For example, vegetation on a restoration site may not always respond in a predictable manner due to local growing conditions and moisture regime (Continental Evaluation Team 1998).

Sampling error, or "partial system observability," is uncertainty that may arise from sampling bias, or imprecision in the sampling conducted under a monitoring program (Continental Evaluation Team 1997). Sampling error may occur where parameters of interest must be estimated from incomplete samples. Structural uncertainty refers to an incomplete understanding of system processes that produce the observed results. In the case of wetlands, incomplete understanding of the physical and biological processes supporting wetland functions, is at the root of assumptions used in mitigation and compensation measures. Untested assumptions are often the main source of uncertainty in the design and implementation of conservation projects and management plans.

Adaptive resource management is most applicable when there is a mandate to manage despite uncertainty, and when research funding is limited. In cases involving wetland mitigation, there is an ongoing need to respond to development initiatives and prescribe management measures. Time is seldom available to find research solutions on an individual project basis. It seems apparent that wetland practitioners will need to develop the bulk of their knowledge from experiential learning in the future. ARM offers a practical framework for achieving this goal for wetland mitigation in Canada.

Adaptive resource management differs from the traditional decision-making process most commonly practised by resource management agencies and is often referred to as adaptive management. In traditional forms of management a single hypothesis or "model" of the system drives the management decision-making process. The model is built on historical and other background information, supported by research to the extent possible and tempered with the insights and experiences of managers. Policy decisions assume this model is the single best representation of how the system works, providing the best estimate of response to the policy or management "treatment."

The strength of ARM is that it explicitly recognizes sources of uncertainty and addresses them at the beginning of the management approach. This approach builds learning into the management process as a distinct objective. Active ARM uses an iterative process of monitoring, assessment and decision-making to test a range of alternative models. Information derived from system responses is used to discriminate among competing models, using a "weighting" system, which permits the most accurate concept to "weigh more heavily" in future decisions.

Application of the active ARM approach recognizes that some management or poli-

cy decisions will be more informative than others in accelerating the learning process, and uses management and policy strategies to inform, as well as to meet more traditional objectives (F. Johnson pers. comm.). Policy decisions are based on a computed balance between the "best" management decision in the short term, and a long-term interest in discriminating the most powerful (if any) among the alternatives (Walters and Holling 1990).

The ARM approach starts with broad questions, which are an expression of the incomplete knowledge about how the "system" of interest behaves or functions (see Figure 3.2). These questions may ponder biological assumptions or the theory used to guide wetland management decisions. Articulating the "right" questions is critical at the outset. These questions should generate explicit hypotheses about the key sources of uncertainty, which affect management performance (Anderson *et al.* 1996).

Hypotheses should be concise and amenable to testing using empirical information as the basis for discrimination among competing ideas. The next step is to calculate the Expected Value of Perfect Information (EVPI). EVPI estimates the net worth of an investment in finding out more about how the system works. EVPI is defined as the gain in management performance resulting from the elimination of uncertainty (F. Johnson pers. comm.).

The establishment of an active ARM process may be cost effective where the potential gains in information are high and the investment in time, money and human resources needed in the monitoring and assessment stages are offset by future savings. Where EVPI is thought to be low, management or policy decisions may be robust with respect to sources of uncertainty. In this case, the best management action is the same whether or not the information is available (Johnson *et al.* 1997).

The following questions are useful in determining whether or not a reasonable potential exists to apply ARM in a given situation (J. Ringelman, pers. comm.):

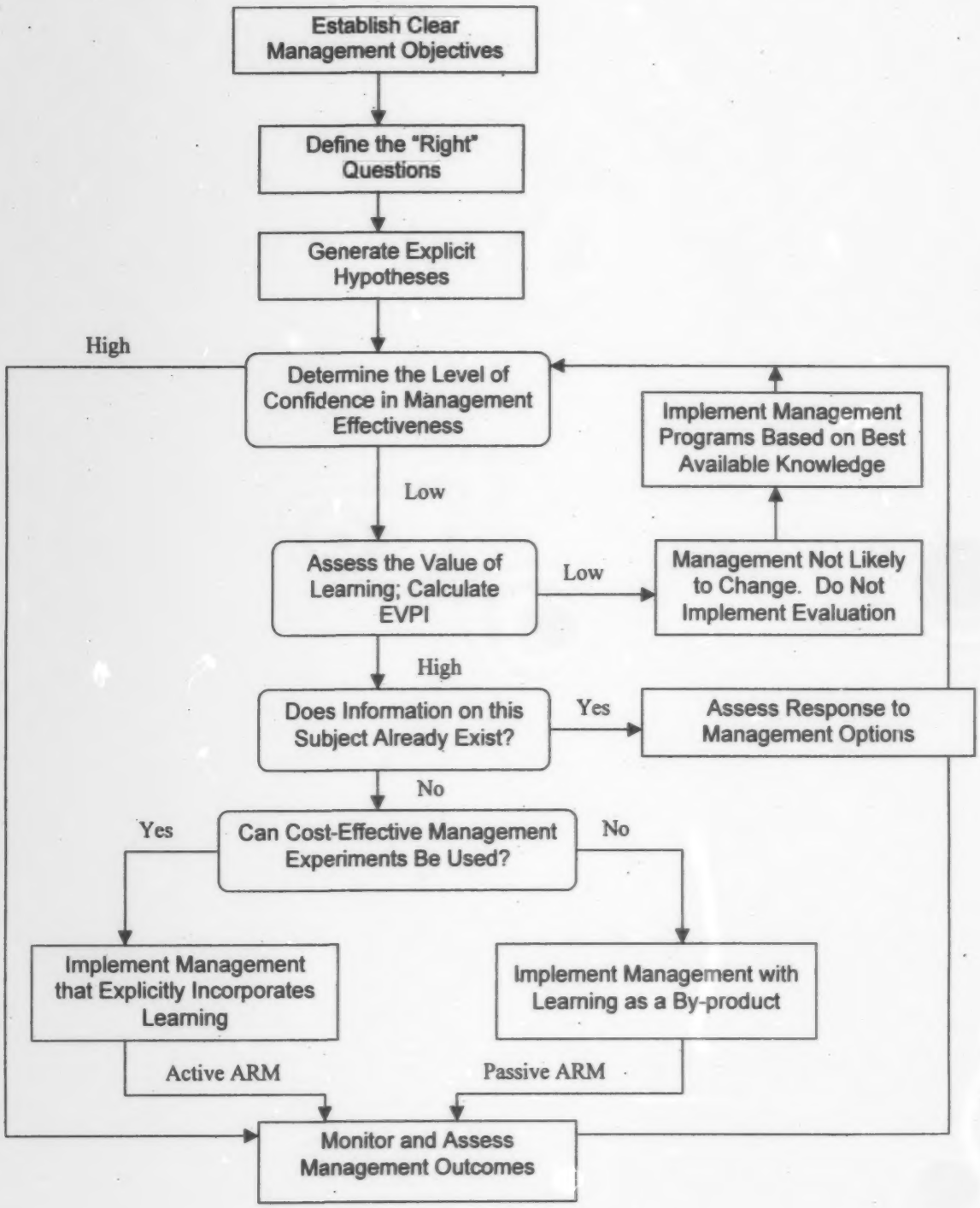
- Can explicit, commonly-held objectives be embraced?
- Do information needs lend themselves to ARM?
- Will resources be re-allocated based on better information?
- Is learning possible?

The adaptive learning paradigm differs from the traditional single-model decision-making approach in a fundamental way, however traditional research focused on well-defined, critical questions is still required to advance learning and the application of knowledge. Most ecological research uses a hypothetical-deductive method (the classical reductionist scientific process) to dissect the phenomena under study into its component parts, where they can be studied in detail. Hypotheses on the basic functions and relationships of interest are established, and predictions from the hypothesis(es) are tested in the field.

Adaptive resource management focuses more on effects to steer learning than causes. It monitors and evaluates the properties emanating from a phenomena under study. Through observation of emerging properties, inferences can be made about the nature of the phenomena, which may be of potential use to decision-makers. To some extent, the advantage of an adaptive management approach is that it bypasses the complexity of systems and a need for knowledge of the details of the internal working relationships, which produce the "net outcome." In many cases, these complexities are beyond the scope of research capability to dissect, understand, and re-integrate in a fashion which would supply timely and reliable direction to decision-makers.

In essence, the adaptive manager does not study the inner workings of the watch when all that is required is the ability to tell time. ARM serves to integrate science and management in ways that are comfortable and productive for managers (Johnson *et al.* 1997). It is a form of "civic science," which pursues reliable knowledge in a manner consistent with awareness and sensitivity to real world constraints faced by public policy makers (Lee 1993).

Figure 3.2
AN ADAPTIVE RESOURCE MANAGEMENT APPROACH


Establish Clear Management Objectives
Define the "Right" Questions
Generate Explicit Hypotheses
High
Determine the Level of Confidence in Management Effectiveness
Implement Management Programs Based on Best Available Knowledge
Low
Assess the Value of Learning; Calculate EVPI
Low
Management Not Likely to Change. Do Not Implement Evaluation
High
Does Information on this Subject Already Exist?
Yes
Assess Response to Management Options
No
Yes
Can Cost-Effective Management Experiments Be Used?
No
Implement Management that Explicitly Incorporates Learning
Implement Management with Learning as a By-product
Active ARM
Passive ARM
Monitor and Assess Management Outcomes

Since time and money are not available to answer all questions about the replacement of wetland functions through traditional research, an adaptive management approach is essential to speed up the learning process and guide decision-making for wetland mitigation and compensation. This does not preclude the need for research on the fundamentals of wetland ecology. Adaptive resource management should be seen as an opportunity to incorporate practical experience in learning processes directed at understanding wetland ecology.

Improving the performance of mitigation measures benefits all players by meeting social, economic and environmental needs, and by saving proponents, agencies and stakeholders time and money. ARM should become the centrepiece, guiding the planning and implementation of wetland mitigation and compensation on federal lands and elsewhere in Canada. A national focal point for planning, implementation, coordination and analysis of adaptive resource management for wetland mitigation, is needed to support the growth of wetland conservation knowledge, in a realistic and effective manner across the country.

Fundamental questions concerning wetland processes and how these relate to practical methods of replacing wetland functions at the project level, need to be identified and addressed in an ARM framework. National coordination of adaptive resource management research, implemented at multiple project locations across the country, would accelerate the advance of mitigation and compensation technology, and provide a source of timely, cost-effective guidance for achieving wetland conservation in Canada.

Roles of the Project Team, Proponents and Governments in the Mitigation Process

The roles of the project team, proponents and governments have tended to overlap in many cases in Canada where the regulating agency also has an interest in proceeding with the project. The overlap often results in governments underwriting a portion of the costs of environmental assessments by providing unlimited access to staff expertise, assistance in field work and sampling, and free helicopter or air-time to consultants working on behalf of the proponent.

It is essential that the roles of proponents and government agencies be clearly separated in the environmental assessment and decision-making process. Working closely with consultants and providing them with resources and services, which they should undertake under contract, often simply expands the profit margin, at the expense of public credibility in the objectivity of government. Public accountability is best served by a clear delineation of the roles and interactions expected of proponents and their consultants, and the regulatory agencies in the beginning.

Project Team roles include:

- building dialogue, awareness and relationships among the principal players, stakeholders and the public in the process;
- organizing the project approach and building the information database;
- receiving advice and input from all sources on the project;
- considering recommendations for the mitigation and/or compensation procedures, measures, options and plans;
- developing innovative approaches, tools or other requirements to achieve conservation or no net loss objectives; and,
- using the best scientific information and experience available to arrive at a harmonized "win-win" situation as opposed to specifying trade-offs.

Proponent roles include:

- providing the resources to fulfill information requirements and to implement the avoidance, mitigation and compensation measures recommended by the panel;
- where compensation is required, the proponent should implement the project without any flow of financial resources through government;
- where compensation banking may be required to increase the flexibility of options, financial banking should be

through a recognized conservation non-government organization or third party in the private, volunteer sector;
- guaranteeing success of the mitigation and/or compensation plan using objective criteria as an indication of the mitigation or replacement of wetland functions; and,
- establishing and maintaining a monitoring system to evaluate the success of mitigation measures and compensation projects. The system should be accessible and transparent to the public.

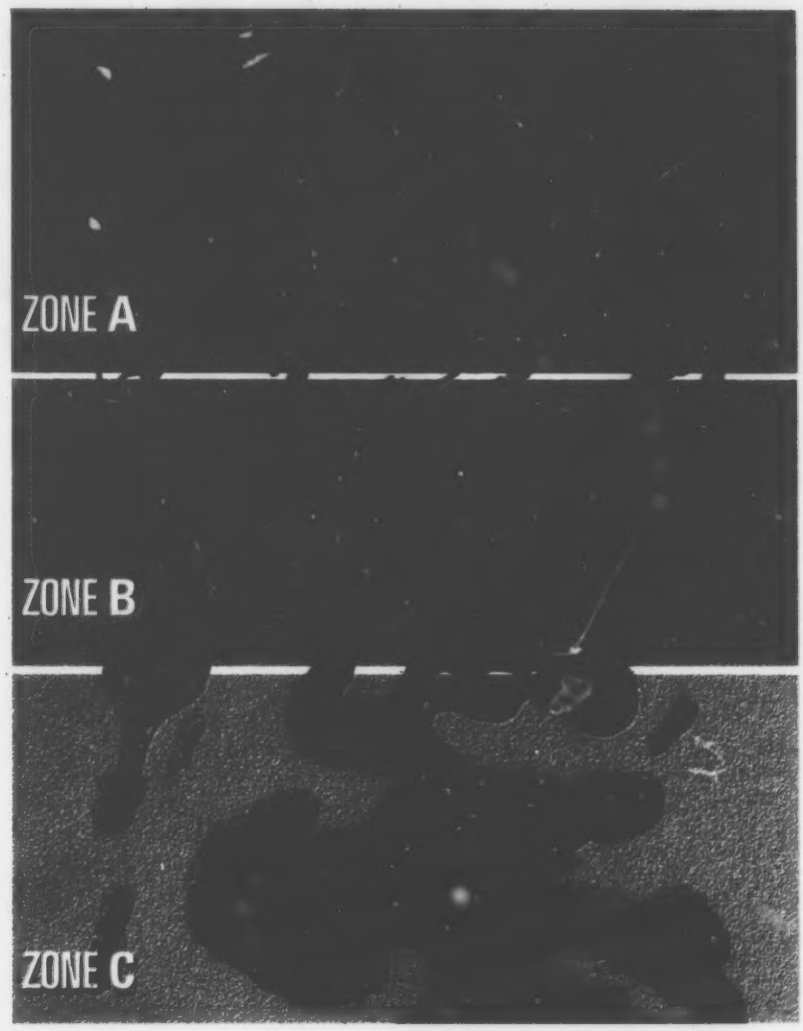
Government roles include:
- ensuring that the public interest is maintained in projects affecting wetlands;
- maintaining adequate expertise to assess the potential impact of development projects on wetlands and to oversee the development and implementation of mitigation and/or compensation projects;
- maintaining an onus on the proponent and his/her consultants to ensure competent environmental assessments and project evaluations are conducted and significant elements addressed;
- maintaining public confidence in, and access to the process;
- checking the project record, qualifications, suitability and capabilities of consultants used to conduct the work and make recommendations;
- ensuring that their wetland conservation objectives are met, and that their legislation and policies are followed;
- reviewing project monitoring and evaluations by the proponents, and ensure procedures are maintained; and,
- promoting the development of wetland management knowledge and technology, through the implementation and coordination of adaptive resource management approaches to wetland mitigation and compensation.

Wetland distribution in a watershed

The type and positioning of wetlands within a watershed are directly related to wetland functions and values in an ecosystem (see Figure 3.3). Several important inferences can be made about functions and values based on this information as a starting point for field assessments.

Environmental assessments should consider the spatial-temporal dynamics of wetlands over seasons, and ecologically relevant time scales, and how these affect

Figure 3.3
DIAGRAM OF WETLAND DISTRIBUTION IN A WATERSHED



functional relationships to the surrounding ecosystem. Assessments based on descriptive "snapshots in time" do not capture the dynamic role of wetlands, and often lead to "conservation" measures that tend to functionally isolate wetlands from the ecosystem. Accurate interpretation of wetland functional relationships is key to planning appropriate mitigation or compensation measures.

The beaver is a singularly key player in wetland dynamics throughout a watershed. Beavers move through a watershed creating new ponds and swamps, then abandoning them to dry and become repopulated with terrestrial species. The relationship between beavers, their prevalent food sources, such as aspen, and riverine systems, plays a basic role in rejuvenating wetland functional capacity in a watershed, over a 30 to 40-year cycle. This dynamic relationship is a key influence in wetland ecosystems in many parts of the country, and an important consideration in wetland mitigation and compensation.

Zone A — is defined by the upper reaches of a typical watershed. In undeveloped environments the terrain tends to be heavily wooded, has higher relief, with shallow soil profiles, small, fast-flowing streams and many intermittent, seasonal tributaries. Soils are often acidic and wetlands tend to be less productive types, such as bogs, fens and some wooded swamp. Early succession wet meadows and swamps may be numerous, but small in size. Several seasonally flooded, small wetlands may not contain water every year, and for the most part, do not resemble wetlands. Nevertheless, these ephemeral depressions contribute to flood control and fulfill a variety of other functions in years of abundant run-off.

The small size, intermittent nature and scattered distribution of wetlands in the upper reaches of watersheds belies the functional importance of this zone in downstream flood abatement, water supply and quality management for fish and wildlife habitat and in ground water recharge. Wetlands in Zone A are important in stabilizing stream banks, in retaining soil in the upper reaches of the watershed, controlling erosion and fish habitat damage from severe storm events, and in contributing to water storage and moderating seasonal flooding.

Developers tend to overlook the importance of wetlands in this zone because they are small, mostly "dried-up" and abundant. However, the development of linear structures, such as roads in this zone, can have sweeping impacts on drainage patterns and wetland functions over an extremely large area. Although the "footprint" of a structure may be very small in proportion to the area left in a natural state, it is the barrier effect of linear structures that can alter drainage patterns and adversely impact wetland functions over a much greater area.

Hydrotechnical studies performed in environmental impact assessments tend to overlook small-scale drainage patterns over a large area, focusing on damage prevention for "significant" elements on the landscape, and to infrastructure. Many barrier structures have insufficient allowance for seasonal water passage, resulting in significant local alteration in drainage, soil moisture, floral communities and habitat functions. It is critical to mitigate all water-crossings, including seasonal streams, with appropriate drainage capability, and to minimize impacts to existing wetlands.

Zone B — is defined by the more gently rolling or flat terrain with deeper soils, slower flowing, larger streams and rivers, and broader, productive floodplains supporting larger wetlands. The nature of potential impacts shifts to larger development projects involving dredging, channelization, draining and filling for transportation, urban and industrial development, or flooding wetland basins for hydro-electric projects. Smaller, early succession wetlands in this zone are removed in land clearing and for agriculture. Erosion, sedimentation and declines in water quality are typical impacts.

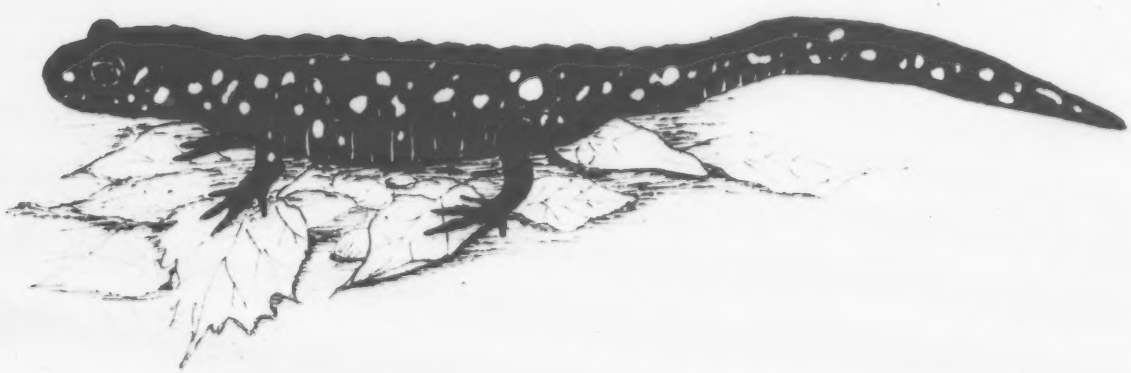
Larger, more productive wetlands in Zone B tend to support a much greater diversity and abundance of fauna and flora per unit area, than the upper reaches of the water-

shed. Areas of critical wildlife and fish habitat become more apparent and easier to delineate. This zone may also contain extensive areas of small to mid-sized wetlands in glacial moraine, such as the prairie pothole country. Individual wetlands have greater capacity for storing run-off and slowing flood water, maintaining a higher water table in the uplands as a hedge against summer drought, and improving water quality by removing contaminants through sedimentation and uptake by aquatic plants. Wetlands in this area are key to containing non-point source pollution of surface and groundwater supplies in agricultural landscapes.

Zone C — is defined by the lower portions of a watershed that tend to contain areas of deep, fertile soils in river deltas and extensive floodplains. The largest, most productive wetlands in a watershed or ecosystem are most often found in the lower portions. These wetlands tend to have the greatest capacity for a wide range of functions, and the highest levels of biological diversity occurring in the ecosystem delineated by the watershed.

The lower reaches of watersheds are most likely to contain human settlements and industrial development. Major river floodplains, deltas, estuaries and the Great Lakes lowlands have attracted the highest human densities in southern Canada. Over 70% of the wetlands in these areas have been removed by urban, industrial and agricultural land use. Remaining wetlands are under constant threat from development, pollution and sedimentation.

Marshes, open water wetlands and swamps are the predominant wetland classes in the lower reaches of a watershed. Marshes and wooded wetlands on floodplains, in bays and along oxbows have a tremendous capacity in an unaltered state to store and slow waters, remove nutrients and sediments, and attenuate flood peaks. These wetlands also exhibit the greatest capacity to support fish, wildlife and biological diversity. Although many remaining wetlands in this zone should not be developed at any cost, the reality is that development is ongoing and is likely to continue. Wetland compensation, competently applied and evaluated under a no net loss, or net gain principle, appears to be the most viable option for maintaining wetland functions and values in situations where development will proceed.



4.0 Reflections

— Kenneth W. Cox

In a world of rapid population growth, which reached 6 billion people in 1999 and will in all likelihood climb to 10 billion by 2070, there will be even more severe effects on our environment than we have experienced to date. Canada will not escape this population growth, nor the development pressures that it will generate. Now is the time to move towards reasoned thought and reasoned responses to that growth and the effect it will have on increased urbanization, industrial development, waste disposal and food production. Environmental disturbance is inevitable and more land and water will be affected. Somehow Canada must move to accommodate this growth and manage its disturbance. Ecological systems, particularly wetlands, will be affected. Retention of these systems is critical to provide potable water, wildlife habitat and a place for these increasing numbers of people to recreate and relax.

To this point in time, no comprehensive document that pulls together the mitigation process thinking and/or examples from across Canada exists. Before this project started, little comprehensive thought had been given to where we came from, where we are or where we are going on this issue. It is the hope of the NAWCC (Canada) that this document will serve as a beachhead for the future on the mitigation process.

The principles, guidelines and framework for applying the mitigation process outlined are the result of many years of active research, consultation and practical application in collaboration with a wide range of interested parties in a variety of economic sectors. It is as comprehensive in nature and reflects at this stage in time, opinion from the professional sectors in Canada that are aware of, or participate in, activities involved in the mitigation process. Hopefully, it will inspire more thought, reflective action and conservation of wetland and other critical ecosystems.

Avoidance, minimization and compensation are components of the mitigation process. Guidelines for these have been outlined. A practical framework for applying such a process has been suggested. Case studies have been referenced and reflected on. Some of the most critical steps and issues in the mitigation process are outlined below:

Functions Approach

Wetland functions, values and benefits were discussed in the opening of the document. It is critical to always have the functions of the wetland or wetland ecosystem to be impacted clearly outlined at all times. Functional evaluation and use of such methodologies is not advanced across Canada, and it is essential to point out to decision-makers, professionals and the public the importance of these habitat types to watershed ecosystems. One measures the health of a wetland by the functions it performs, not just by the amount of water visible or the wildlife around it. No point is more critical than this one.

Avoidance

This must always be the first step. Detecting projects before construction begins is more than half the battle. Canadians have lost a large percentage of their wetlands in many different ecoregions. Too often, those involved in wetland disturbance want to jump to compensation, want to write a cheque and be done with the frustration of dealing with Mother Nature and the environmental impact process. Ducks and turtles cannot swim, eat and breed in a "cheque." Even if a newly-created wetland is proposed, it may not function properly. While some wetlands can be constructed, most cannot. Avoidance is the first and most important component of the mitigation process.

Multidisciplinary Team of Experts

One cannot enter into a mitigation process and expect to do justice to the system under the threat of being impacted, without advice from wetland hydrologists, ecologists, biologists, engineers, restoration specialists and community leaders. The

functions approach, which the vast majority of Canadian wetland policy or guidelines is based on, demands this. Most projects ignore this critical step — critical not only to the protection of the wetland but also to educating and communicating wetland importance to other sectors of society.

Pre-Project Baseline Data

Undertake a thorough inventory of available data and resources (see Bond *et al.* 1992). A great deal of existing information is available. As well, insist on a pre-project baseline data study. It is impossible to work through the mitigation process in a scientific and rational way without data. Data must also be collected throughout the process if the intrusion proceeds.

Public Participation

The process should involve public stakeholders, in many cases the owners of the wetland being impacted. It is essential to bring them and their potential power "on side." In most instances, the printed or visual media will pay more attention to the public than they will to the team working on the mitigation process. Never underestimate the power of the public — they may be the most important factor in obtaining avoidance.

Project Design and the Mitigation Plan

An environmental assessment should be part of the project design. It should not be an afterthought. Environmental assessment is a relatively new process in Canada and is not always well understood. Project proponents understand the requirement of an environmental assessment, legally and politically. But do they enter into the environmental assessment with the intention of full documentation or full concern that might lead to avoidance or to providing a sound basis for the minimization of project disturbance? Many just see it as a part of the permitting process. Attention to the steps outlined in this section will help pressure proponents to an open and transparent environmental assessment.

On-Site Supervision

The environmental assessment is not a mitigation plan. It merely detects residual impacts. Mitigation plans address them. If the project is approved, on-site supervision should be one of the requirements of the mitigation plan. Not only is it critical to have part of the mitigation team on site to monitor the process agreed to, but it is also critical to monitor progress and process so that mid-course corrections can be undertaken. Part of this involves education of, and monitoring, the various components of construction (for example, heavy equipment operation, toxic material storage). On-site operators and supervisors are critical to the proper completion of an agreed-to minimization plan. As well, having a monitor on site allows discussion with, and therefore, education of, project developers, workers, media, public and others who work at, or visit the site, during the wetland's disturbance.

Long-Term Monitoring and Contingency Planning

While monitoring is not specifically included by name in the mitigation process, it is important for measuring the effectiveness of the minimization and compensation measures outlined for the project. Ask the following questions. Will the proponents/opponents of the project being worked on be in a position to measure the success of prescribed measures after project completion? How effective was the entire mitigation process three, five and ten years after the disturbance has taken place?

Learning and Adaptive Management

Consider documenting in print or through video the wetland and its proposed or delivered disturbance. Document the steps outlined here, and any other steps that are considered important. In this way, other people can learn from the experience and the information that such a new case study can provide to help improve wetland management and the mitigation process in the future.

These nine steps and/or actions are the most important in designing and implementing a mitigation process. As such a mitigation sequence is refined, adapted for use and implemented in a variety of disturbance situations across the country, it is hoped that serious impacts to wetlands and/or wetland systems can be avoided or minimized, thus protecting one of our most important natural resources.

5.0 Glossary

Avoidance: The prevention of impacts, either by choosing an alternate project, alternate design or alternate site for development. This is the first choice of mitigation alternatives, particularly for high quality/unique wetlands, and wetlands of national or international importance. It should also be the choice in situations where cumulative impacts in a specific area exceed a certain threshold, and where impacts of even a small magnitude will result in significant negative effects.

Benefits: Products, services or experiences that flow from wetland functions and values.

Compensation: A last resort in the mitigation process, compensation refers to a variety of alternatives that attempt to "make up for" the unavoidable loss of or damage to wetland functions and values, usually by improving wetlands off-site from the development. Preferred methods include **restoration** and **enhancement** of wetlands, although the **creation** of a new wetland would also be a potential compensation method. **Securement** of a wetland alone would not normally be considered adequate compensation because it would not result in the replacement of lost or damaged wetland functions. However, there may be situations in which a combination of securement and other compensatory measures may be appropriate. Compensation may also include the financing of wetland-related activities such as research and education.

Creation: The conversion of a persistent non-wetland area into a wetland through some human activity. This definition assumes that the site has not been a wetland within recent times (100 to 200 years) (Lewis 1990). Simply put, creation refers to the construction of a wetland where none previously existed.

Enhancement: The increase in one or more values of all or a portion of an existing wetland by human activities, often with the accompanying decline in other wetland values (Lewis 1990).

Functions: The natural properties and processes (physical, chemical or biological) associated with wetland ecosystems.

Minimization: The reduction of adverse effects of development on the functions and values of wetlands, at all project stages (including planning, design, implementation and monitoring), to the smallest practicable degree.

Mitigation: A process for achieving wetland conservation through the application of a hierarchical progression of alternatives, which include:

(a) **avoidance** of impacts;
(b) **minimization** of unavoidable impacts; and
(c) **compensation** residual impacts that cannot be avoided.

Restoration: Lewis (1990) defines restoration as "Returned from a disturbed or totally altered condition to a previously existing natural or altered condition by some human action. Restoration refers to a return to pre-existing conditions." However, in many situations restoration efforts do not result in the original condition, but to a more realistically achievable "natural" condition.

Securement: The protection of a wetland, usually through tenure, formal agreement, policy or legislation. Securement normally refers to a long-term or permanent state, generally achieved through direct acquisition or the granting of a conservation easement or covenant.

Values: Anthropocentric or human-centred capabilities that derive from wetlands; often divided into science/information, aesthetic/recreational, cultural/psychological, and production (or similar) categories.

Wetland: "Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment" (National Wetlands Working Group 1988).

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